		Expenditures.	*Cr.*
		By building and repairs	$2,943 13
		By heat, light and water	2,555 53
1912.		By tools, implements and machinery	303 62
Sept.	30.	By balance	2 63
			$5,804 91

Salaries.

1911.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand	$5,574 08
		To amount received from Comptroller	52,000 00
			$57,574 08

		Expenditures.	*Cr.*
1912.		By salaries	$52,419 33
Sept.	30.	By balance	5,154 75
			$57,574 08

Labor.

1911.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand	$858 56
		To amount received from Comptroller	15,800 00
			$16,658 56

		Expenditures.	*Cr.*
1912.		By labor	$16,618 13
Sept.	30.	By balance	40 43
			$16,658 56

SPECIAL FUND — HORTICULTURAL INVESTIGATIONS.

1911.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand..............	$18 27

1912.		*Expenditures.*	*Cr.*
Sept.	30.	By balance	$18 27

FERTILIZER INSPECTION.

1911.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand..............	$109 11
		To amount received from Comptroller.	10,000 00
			$10,109 11

		Expenditures.	*Cr.*
		By chemical supplies	$1,071 82
		By contingent expenses	3 00
		By freight and express.............	47 68
		By heat, light and water...........	168 90
		By postage and stationery..........	1 25
		By publications	1,811 70
		By salaries	6,440 63
1912.		By traveling expenses	95 39
Sept.	30.	By balance	468 60
			$10,109 11

CONCENTRATED FEEDING STUFFS INSPECTION.

1911.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand..............	$98 83
		To amount received from Comptroller.	3,500 00
			$3,598 83

	Expenditures.	*Cr.*
	By chemical supplies	$63 45
	By contingent expense	50
	By freight and express.............	114 00
	By heat, light and water...........	106 30
	By postage and stationery..........	10
	By publications	1,815 49
	By salaries	1,206 76
	By seeds, plants and sundry supplies.	3 20
1912.	By traveling expenses	70 98
Sept. 30.	By balance	218 05
		$3,598 83

CHAUTAUQUA GRAPE INVESTIGATION FUND.

1911.	*Receipts.*	*Dr.*
Oct. 1.	To amount received from Comptroller.	$4,248 75

Expenditures.	*Cr.*
By chemical supplies	$256 03
By contingent expenses	19 40
By fertilizers	72 25
By freight and express.............	8 03
By heat, light and water...........	2 24
By labor	250 00
By postage and stationery..........	21 81
By salaries	3,025 57
By seeds, plants and sundry supplies.	367 53
By traveling expenses	225 89
	$4,248 75

INSURANCE MONEY.

1911.		*Receipts.*	*Dr.*
Oct.	1.	To balance on hand	$22 07

1912.		*Expenditures.*	*Cr.*
Sept.	30.	By balance	$22 07

ADAMS FUND.

	Receipts.	*Dr.*
1.	To receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1912, under act of Congress approved March 16, 1906	$1,500 0

Expenditures.	*Cr.*
By salaries	$1,500 0

HATCH FUND.

Receipts.	*Dr.*
To receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1912, under act of Congress approved March 2, 1887	$1,500 0

Expenditures.	*Cr.*
By labor	$829 67
By salaries	670 33
	$1,500 00

All expenditures are supported by vouchers approved by the Auditing Committee of the Board of Control and have been forwarded to the Comptroller of the State of New York.

(Signed) W. O'HANLON,
Treasurer.

MAINTENANCE FUNDS.

The funds available for the support of the institution during the fiscal year ending September 30, 1912, were as follows:

Salaries	$52,000
Labor	15,800
Maintenance of the work of the Station departments	22,500
General expense, heat, light, water, repairs, etc	5,500
Total	$95,800

Expense of chemical work in analyzing samples of fertilizers and feeds submitted as required by law by the Commissioner of Agriculture:

Fertilizer inspection	$10,000
Feeding stuffs inspection	3,500
Total	$13,500

The State appropriations for the current fiscal year are as follows:

Salaries	$52,000
Labor	15,800
Maintenance of work of Station departments	24,000
Special grape work in Chautauqua county	7,500
General expense, heat, light, water, repairs, etc	5,500
Total	$105,800

Expense of chemical work in analyzing samples of fertilizers and feeds submitted as required by law to the Commissioner of Agriculture:

Fertilizer inspection	$11,000
Feeding stuffs inspection	4,500
Total	$15,500

Owing to a failure to receive from the Legislature any appropriation for 1912 for the Chautauqua grape work, it became necessary to support this work from the general funds of the institution during the last four or five months of the fiscal year ending September 30, 1912. This placed limitations on our work both at the Station and in the Chautauqua district.

ESTIMATED FINANCIAL NEEDS OF THE INSTITUTION FOR THE FISCAL YEAR 1913–1914.

In making public the estimates decided upon by your Board as needed appropriations for the institution during the fiscal year 1913-1914 it is proper that certain explanations should be offered.

It will be noticed that the items requested for the maintenance of the Station for the next fiscal year, outside of the aid given the Commissioner of Agriculture in the administration of agricultural law, exceed the appropriation for the present year by $16,700. This increase is distributed among the items for salaries, labor and expenses for maintaining the various lines of research and experimentation carried on by the institution.

It is easily seen that this increase is not requested for any single purpose, but is regarded as necessary because of the general enlargement of the activities of the Station due to the steady growth of the demands made upon us by the agricultural public. It should not be forgotten in this connection that agricultural practice has undergone, during the past few decades, very far-reaching changes largely in the direction of a steadily increasing dependence upon the conclusions of science. For this reason, the agricultural public is more and more turning to such agencies as the college of agriculture and the experiment station for the solution of problems and for direction in farm practice. It may be said that there seems to be no limit to what may be expended in agricultural research and education and it is true that the amounts appropriated by the State for the support of its agricultural agencies has been steadily increasing until they are now an important item in the State's annual financial budget.

The real question to be considered, however, is whether these expenditures are profitable, whether it is really worth while to secure and apply knowledge that results in more economical production, whether it is worth while to defend the farmer against pests, which, without the application of modern methods, would render almost impossible the production of certain farm crops. It is safe to assert that the action of the State Legislature in liber-

ally supporting the various agricultural agencies that have been established is heartily ratified, on the basis of experience, by the intelligent agricultural public.

If this institution is to meet the increasing demands made upon it, it must have more liberal financial support and it is for this reason that your Board has asked for enlarged resources for the following fiscal year.

The items decided upon are as follows:

For salaries	$60,000
For labor	18,000
Maintenance of work of Station departments	28,000
Investigations in the interests of grape growing	10,000
General expenses, including heat, light, water, repairs, etc	5,500
Total	$121,500

It has become the policy of the State to regulate, through inspection laws, the sale of various commercial articles important to the farmer, including commercial fertilizers, concentrated feeding stuffs, fungicides and insecticides, and agricultural seeds. In addition to this, all glassware used in measuring the fat content of milk and cream, where such products are bought on the fat basis, must be inspected and marked by this institution. The first inspection law enacted in this State related to commercial fertilizers, which was followed some years later by an act regulating the sale of concentrated feeding stuffs. There has gradually followed inspection along the other lines mentioned.

The chemical and other scientific work involved in this inspection has all been placed among the required duties of the Director of this institution, but for only two lines of inspection, viz., fertilizers and feeding stuffs, are special funds provided to meet the necessary expense. Whatever has previously been accomplished in the analysis of fungicides and insecticides, in the examination of agricultural seeds and in the testing and marking of Babcock glassware has been done by the use of funds not appropriated for these purposes. The time has now come when there must be some recognition in our maintenance appropriation of the expense involved in these required duties.

The expense in these several directions is not itemized for each line of work for the reason that the same force of chemists is active along these several lines, which is true of other departments of the Station, and it is somewhat difficult to make divisions of salaries and other expenses on an exact basis of time used and of laboratory expenditures. The item is, therefore, presented as follows:

Upon enforcing the provisions of the law in relation to commercial fertilizers, concentrated feeding stuffs, fungicides and insecticides, agricultural seeds, and the testing and marking of Babcock glassware..........	$18,000

PUBLICATIONS.

The publications of the Station fall under six heads:

(1) *Technical Bulletins,* the subject-matter of which is technically scientific and sets forth the results of investigations that are regarded as fundamental to succeeding attempts at the solution of practical problems. The bulletins are not intended for popular use and have a limited circulation.

(2) *Complete Bulletins,* which give in full detail the methods followed in studying certain practical problems and the entire data from which the conclusions are drawn. Through such complete statements, every investigator or experimenter is bound to set forth the results of his work in order that his methods and conclusions may be open to the fullest inspection and criticism. This is especially to be desired if it is expected that the dicta of Station publications are to be accepted and applied in practice. The complete bulletins of the Station are evidently found useful by many teachers both in colleges and in schools of a lower grade. They are also sought by a small percentage of persons engaged in practical agriculture.

(3) *Popular Bulletins* are somewhat popular presentations of the more extensive and more technical subject-matter of the complete bulletins. They are intended to make plain to the non-

scientific reader the practical bearing and application of the results of the Station investigations. These bulletins are written by the Station Editor, in all cases in consultation with the member of the staff who is responsible for the complete bulletin under consideration.

The experience of fifteen years has taught us that the presentation to the public of our work through the popular bulletins is a more efficient way and financially a more economical way than to issue the complete form to the entire mailing list. We have reason to believe, also, that the public regards our methods as satisfactory.

A glance at the figures below will show that the complete bulletins are desired by a comparatively small proportion of our mailing list.

(4) *Circulars* are prepared as a means of placing information in the hands of a special class of practitioners, such as cheesemakers or apple growers. These also aid in replying to the numerous requests for information that come to the Station. They are not for distribution to our general mailing list.

(5) *Leaflets,* mostly of such a size as may be enclosed in an ordinary correspondence envelope, are informational briefs that are prepared and used as a means of lessening the immense labor of correspondence that is imposed on the Station, which, at the best, sometimes taxes the energies of the members of the staff to an extent that hampers their more important activities.

(6) *Annual Reports* are intended to be complete presentations of the status and work of the Station, each report covering a calendar, rather than a fiscal, year.

They are made up chiefly of the complete bulletins. In accordance with law, they are submitted to the Commissioner of Agriculture and are printed as a part of his annual report, 2,000 copies being assigned to the Station.

The fruit publications of the Station, viz., The Apples of New York, The Grapes of New York and The Plums of New York, constituted one part of the annual reports of the Station for the

years 1903, 1907 and 1910, respectively. The original editions of these publications were as follows:

Apples of New York	19,000
Grapes of New York	9,000
Plums of New York	9,000

These were divided for distribution into three lots.

Members of the Legislature:	
Apples of New York	15,000
Grapes of New York	5,000
Plums of New York	5,000
Commissioner of Agriculture:	
Of each publication	2,000
Agricultural Experiment Station:	
Of each publication	2,000

The Legislature of 1912 authorized the printing of 5,000 more copies of The Apples of New York of which 4,530 copies were assigned to the Legislature and 470 copies to the Station. The number which the Station will have for distribution will average less than eight for each county, provided none are retained for future needs. It is evident that from our quota we can not meet extensive demands for this publication. The endeavor will be to place our supply of copies where they will be of the greatest possible use as a means of education.

The supply of both the Grapes of New York and the Plums of New York is now practically exhausted, a limited number of copies being retained to meet future library, school and professional needs within the State.

Bulletins in the several forms are now issued as follows:

POPULAR BULLETINS.

Residents of New York	38,465
Residents of other States	2,153
Newspapers	780
Experiment stations and their staffs	1,756
Miscellaneous	100
Total	43,254

COMPLETE BULLETINS.

Experiment stations and their staffs	1,756
Libraries, scientists, etc	300
Foreign list	320
Individuals	3,367
Miscellaneous	100
Total	5,843

NEW CONSTRUCTION AND REPAIRS.

The Legislature of 1912 appropriated $3,000 to replace and equip the carpenter shop destroyed by fire in the winter of 1912. The building is now in process of construction under a contract which leaves a balance sufficient to purchase the necessary tools and other equipment.

The general repairs which it is necessary to make include painting some twenty-seven buildings, repairs to the buildings on the farm purchased in 1911 and the renovation of the interior of the Chemical Laboratory. It is now evident that this will be accomplished at an expense that will leave, out of the $6,000 appropriated for these purposes, a balance sufficient to make some other needed repairs.

A NEW BUILDING.

An appropriation for the much needed Administration and Demonstration building has been made by three Legislatures and in each instance, disapproved by the Governor on the ground of an insufficiency of funds.

The amount which your Board has decided to ask for this purpose, one hundred thousand dollars ($100,000), is considerably larger than the previous requests for the following reasons: The Soils Investigation Department, located in the Chemical Building, needs for its development space now used for dormitory purposes, and the space in the present Administration Building (the old mansion house bought with the Station farm) should be converted into living rooms for members of the staff. This means the transference of the library to new quarters, which should be fireproof, as the Station library is now valuable.

Aside from the above reason for the erection of a new building, to contain administrative offices, demonstration space, the library and an audience room, the following needs justify the request of your Board, which are restated here as given in my last two reports.

(1) There is no place at the institution where an audience can be assembled, excepting out of doors in the pleasant days of the warm season. This is wrong; for the work of the Station stands in such relation to educational interests and farm practice that some way of assembling audiences on the Station ground and bringing them into close range with the Station activities and results should be made possible.

(2) It is extremely desirable that space shall be provided where the results of Station work can be illustrated in a concrete form. We have many visitors who state that they come to see what the Station is doing, not realizing that in the progress of our inquiries they can only see a single point in the progress of an experiment or investigation, which to the untrained eye may be meaningless.

Space is needed for the objective display of results that have been reached in dairy work, in the study of farm pests, field experiments and in other directions. Such an exhibit would be especially useful and instructive in connection with meetings here of horticultural societies and other bodies interested in special lines of production.

(3) The number of the scientific staff is now such that more office room is needed. This can be provided by removing the museum collections in the building now occupied by the departments of bacteriology, botany, dairying, entomology and horticulture, to the proposed new building.

(4) The building now used for administrative and library purposes is needed for other uses. It has come to be necessary to arrange for boarding the unmarried members of the staff at some point nearer than the city. Rooms are now available on the Station grounds, but arrangements for meals near the Station are now difficult and uncertain, sometimes impossible. With slight ex-

pense the building now used for offices and library could be adapted to the uses indicated and it would be a much needed convenience. Getting a noon lunch a mile or a mile and a half away occasions either much loss of time or such haste as is equally detrimental to health and good work.

FIELD WORK CARRIED ON BY THE STATION IN VARIOUS PARTS OF THE STATE.

It is not possible for the Station to study the numerous problems which it undertakes to solve through experiments or observations on the Station farm, or even on farms in the vicinity of the Station. It is necessary to locate field work in those places where the problems exist, as, for instance, among pear growers for the study of the pear thrips, or among potato growers for the study of the methods and economy of spraying. This necessity has led to the location of experimental work, during 1912, in fifty-six towns in the State on ninety-seven farms. There follows a list of this experimental work giving the subject of the experiment, the name of the farmer or fruit grower co-operating and the location of the experiments. Acknowledgment should be made to all of these gentlemen for their hearty co-operation in carrying out the details of the work undertaken.

Outside Work Carried on by the Station During the Season of 1912.

BOTANICAL DEPARTMENT: EXPERIMENTAL.

Nature of Experiment.	*Co-operator.*	*Location.*
Control of currant diseases.	James R. Clark..........	Milton.
Causes of poor potato stand	F. A. Sirrine.............	Riverhead.

ENTOMOLOGICAL DEPARTMENT: EXPERIMENTAL.

Control of apple aphis.....	Frank Bacon.............	Albion.
Control of apple aphis.....	John Beckwith...........	New Haven.
Control of apple aphis.....	William Bugbee..........	Gasport.
Control of apple aphis.....	Lyman Burrows..........	Albion.
Control of apple aphis.....	Chas. Dunkelberger.......	Gasport.
Control of apple aphis.....	Samuel Smith............	Albion.
Control of cabbage aphis...	Daniel De Lea...........	Seneca Castle.
Control of cabbage aphis...	Tuttle & Russell.........	Williamson.
Control of cabbage aphis...	T. D. Whitney...........	Stanley.
Control of cabbage maggot.	L. A. Page..............	Seneca Castle.
Control of cranberry leaf-hopper	R. C. Brown.............	Riverhead.

Nature of Experiment.	*Co-operator.*	*Location.*
Control of grape insects ...	James Barnes............	Prospect Station.
Control of grape insects ...	Louis Bourne............	Westfield.
Control of grape insects ...	H. L. Cumming..........	Fredonia.
Control of grape insects ...	Charles Horton	Silver Creek.
Control of grape insects ...	S. J. Lowell.............	Fredonia.
Control of grape insects ...	M. J. Sackett (2 lines)	W. Irving.
Control of grape insects ...	Chas. Secord.............	W. Irving.
Control of green pear bug..	G. W. Dauchy............	Pavilion.
Control of green pear bug..	E. E. Crosby.............	Lockport.
Control of Hessian fly.....	H. F. Daboll.............	Clyde.
Control of Hessian fly.....	Experiment Station.......	Geneva.
Control of Hessian fly.....	G. E. Wolcott............	Corning.
Control of pear psylla.....	Frank Gibson............	Albion.
Control of pear psylla.....	F. E. Hanlon............	Medina.
Control of pear psylla.....	H. B. Treichler...........	Sanborn.
Control of pear thrips.....	Ashley & Rockefeller......	Germantown.
Control of pear thrips.....	C. E. Hover.............	Germantown.
Control of pear thrips.....	A. W. Hover & Bro......	Germantown.
Control of pear thrips.....	Clarence Snyder..........	North Germantown.
Control of pear thrips.....	Spencer Bros.	Hudson.
Control of willow beetle ...	Mrs. L. C. Parshall.......	Lyons.
Control of willow snout beetle	W. & T. Smith Co........	Geneva.
Control of willow weevil...	Stuart Nursery Co.......	Newark.
Control of willow weevil...	W. & T. Smith Co........	Geneva.

ENTOMOLOGICAL DEPARTMENT: DEMONSTRATION.

Control of green apple aphis.	E. E. Barnum............	Albion.
Control of green apple aphis.	E. L. Chapman...........	Albion.
Control of green apple aphis.	E. E. Crosby............	Lockport.
Control of green apple aphis.	Yale Forbes	Brockport.
Control of green apple aphis.	Frank Gibson............	Albion.
Control of green apple aphis.	F. E. Hanlon.............	Medina.
Control of green apple aphis.	John Larwood	Albion.
Control of green apple aphis.	Albert Wood Estate......	Carlton.
Control of cabbage maggot..	Alfred Armington........	Orleans.
Control of cabbage maggot..	James Brewer...........	Stanley.
Control of cabbage maggot..	W. T. Cooper............	Seneca Castle.
Control of cabbage maggot..	Daniel De Lea...........	Seneca Castle.
Control of cabbage maggot..	T. C. Hays..............	Seneca Castle.
Control of cabbage maggot..	Benjamin Jones..........	Orleans.
Control of cabbage maggot..	W. P. Jones.............	Stanley.
Control of cabbage maggot..	L. D. Knapp.............	Seneca Castle.
Control of cabbage maggot..	Robert Ritchie	Seneca Castle.
Control of cabbage maggot..	O. W. Winburn...........	Seneca Castle.
Control of pear psylla	Jay Allis	Medina.
Control of pear psylla	Frank Bacon	Albion.
Control of pear psylla	Spencer Brownell.........	Oswego.
Control of pear psylla	E. L. Burt...............	Hilton.
Control of pear psylla	Collamer Bros.	Hilton.
Control of pear psylla	John Cramer	Middleport.
Control of pear psylla	Frank Curtis	Hilton.
Control of pear psylla	Chas. Du Colen..........	Hilton.
Control of pear psylla	C. E. Ernest.............	Gasport.

Nature of Experiment.	*Co-operator.*	*Location.*
Control of pear psylla	F. P. Hazelton	Le Roy.
Control of pear psylla	S. S. Hopkins	Youngstown.
Control of pear psylla	H. E. Horn	Albion.
Control of pear psylla	F. B. Howell	Medina.
Control of pear psylla	F. J. Klafelin	Hilton.
Control of pear psylla	S. W. McCollum	Lockport.
Control of pear psylla	E. Moody & Sons	Lockport.
Control of pear psylla	C. G. & R. L. Oaks	North Rose.
Control of pear psylla	A. C. Pease	Oswego.
Control of pear psylla	Ira Pease	Oswego.
Control of pear psylla	L. R. Rogers	Albion.
Control of pear psylla	David Smith	Middleport.
Control of pear psylla	Delos Tenny	Hilton.
Control of pear psylla	F. M. Tenny	Hilton.
Control of pear psylla	W. W. Williams	Hilton.
Control of pear psylla	Albert Wood Estate	Albion.
Control of pear psylla	F. M. Woolworth	Youngstown.
Control of pear psylla	Lawrence Wright	Hilton.

HORTICULTURAL DEPARTMENT: EXPERIMENTAL.

Apple orchards, dwarf	Wood Orchard	Carlton Station.
Apple orchards, dwarf	F. E. Dawley	Fayetteville.
Apple orchards, dwarf	Edward Van Alstyne	Kinderhook.
Apple orchards, fertilizers for	W. D. Auchter	South Greece.
Apple orchards, tillage of ..	W. D. Auchter	South Greece.
Apple orchards, tillage of ..	Grant Hitchings	South Onondaga.
Grapes, fertilizers for	H. Benjamin	Fredonia.
Grapes, fertilizers for	S. S. Grandin	Westfield.
Grapes, fertilizers for	C. M. Hamilton	Ripley.
Grapes, fertilizers for	Miss Frances Jennings	Silver Creek.
Grapes, fertilizers for	H. G. Miner	West Sheridan.

SOILS DEPARTMENT: EXPERIMENTAL.

Alfalfa, fertilizers for	W. P. Mead	Jamestown.
Alfalfa, fertilizers for	E. N. Bolt	Watkins.
Apples, fertilizers for	R. B. Densmore	Albion.
Nursery stock, fertilizers for	W. & T. Smith Co	Geneva.
Peaches, fertilizers for	T. H. King	Trumansburg.
Pears, fertilizers for	Lawrence Howard	Kinderhook.
Pears, tillage and cover crops	L. L. Morrell	Kinderhook.
Young vineyard, fertilizers for	D. W. Blood	Fredonia.
Young vineyard, fertilizers for	S. E. Stone	Fredonia.

THE STATION FARM.

The Station farm, including the grounds on which the buildings are located, now comprises about two hundred and twenty (220) acres. Approximately four-fifths of this area is devoted to experi-

ments, horticultural work occupying the larger part. Only a small part of the land is given up to general farming as a means of sustaining the dairy herd.

The Station authorities are sometimes questioned as to the profits of the farm under scientific management. The farm does not return a profit in dollars and cents and if it did, it would be a miserable failure. It is regarded very properly as a piece of apparatus to be used in agricultural investigation and when so used, it not only returns no profits, but is a heavy bill of expense. This would be easily understood by anyone who would take the trouble to learn the details of our experimental work. For instance, the varieties of fruit on the farm number several thousand, at times as many as 10,000. With the large fruits there are but two or three trees of a variety and with the small fruits only a short row of vines or bushes for each kind. Careful records are kept of these fruits which, in the case of the varieties that we have bred, are much in detail and time-consuming. The fruits can not be handled to advantage commercially because there is so small an amount of each kind.

As another illustration, there is under cultivation a twelve-acre field that has been handled experimentally for sixteen years. This field is divided into eight plats and is devoted to a rotation of crops. In order to secure the data desired, the weighed fertilizers and farm manures are put on with great care so as to secure uniform distribution. The crops are weighed and sampled. Great pains is taken to secure uniformity of treatment on all the plats outside of the differences in fertilizers. This requires care in every detail at a much greater expense than would be incurred on a farm managed merely for commercial purposes.

The dairy herd here is a fine one and very productive, but it is constantly under experimental observation for such purposes as testing milking machines, determining the important factors in milk sanitation and making observations of other kinds. Now all this work can not be done in the way which is essential to accurate experimentation without incurring several times the expense that

would be necessary for mere commercial operations. It is for these reasons then that an experimental farm should be regarded as a failure if it returns a financial profit, because the existence of such profit would mean that little experimental work of a high character is carried on.

INVESTIGATION.

ANIMAL NUTRITION.

The problems pertaining to the feeding of animals are among the most complex and difficult of solution with which science has to deal. This is due largely to the fact that the processes of nutrition are hidden. Direct observations are, in the main, not possible, and the conclusions reached must be largely inferential in their nature. When a milch cow, for instance, consumes a given quantity of food of a certain kind, we have as exterior results the production of a certain quantity of milk and the maintenance of the body of the animal at a given weight, or with a gain or loss in body substance as the case may be. These measurements give little clue to the function of the various constituents of which the food is composed.

The study of the problems of animal nutrition enters the field of both chemistry and physiology and the patient studies carried on during the past half century have revealed a great many facts which we now regard as thoroughly established. We know much about the functions of ash constituents, proteins, carbohydrates and fats and we have quite definite data as to the quantities of nutrients necessary to support the various classes of animals under given conditions. This knowledge is embodied in feeding standards.

In recent years, these standards appear to be shifting from quantities of nutrients to energy measurements, this change having been brought about by exhaustive studies of energy and heat relations by the aid of what is known as the respiration calorimeter.

At present, studies in animal nutrition are turning from what may be called bookkeeping with the animal organism, that is, a study of balances of matter and energy, to researches concerning the specific reactions of individual compounds upon the animal organism, and it is along this line that we may expect the most useful future progress in the knowledge of feeding animals.

Some seven years ago, the writer instituted investigations that were intended, as their primary object, to get additional data, if possible, concerning the relation between the production in the milch cow of the phosphorus-bearing body in the milk, known as casein, and the supply in the food of certain phosphorus-bearing compounds. In attempting to carry on such an investigation, it was found desirable to compare a ration having a high phosphorus content with one low in phosphorus, even lower than the demands of a producing cow. This led to the leaching of wheat bran with a slightly acid solution in order to reduce the phosphorus content to the lowest possible limit, this so-called "washed bran" to constitute a considerable part of the low phosphorus ration. In comparing a ration containing unwashed bran with one containing washed bran, marked physiological differences in effect were observed, these differences being the following:

1. Drier and much firmer feces with the washed bran ration, accompanied by a constipated condition, requiring in some cases the use of a purgative.

2. A marked disturbance of appetite (in Experiment 3) when a sudden change was made from the washed bran ration to the one containing the unwashed bran, indicating some specific physiological influence of the compound or compounds removed from the bran by leaching.

3. A greatly reduced flow of urine following a change from the unwashed bran to the washed bran ration, the reverse taking place when a reverse change was made.

4. An increase in the flow of milk consequent upon the withdrawal from the ration of the phytin and other water-soluble constituents of bran.

5. A reduction, sometimes large, in the percentage of fat in the milk consequent upon the withdrawal from the ration of phytin and other water-soluble constituents of bran.

6. A decreased production of butter-fat during the period the washed bran ration was fed, notwithstanding a somewhat increased flow of milk.

7. The entire cessation of the œstrum period with cow 1 and a temporary disturbance of this period with cow 2.

8. The foregoing effects were observed chiefly in experiments 1 and 3, in which the difference in the phosphorus content of the two rations was brought about by leaching the phytin and other soluble compounds out of the wheat bran. In experiment number 2 where the phytin content was small and remained unchanged, similar physiological influences were not sufficiently marked to place much emphasis upon them.

No definite conclusions were reached as to the compound, or compounds, withdrawn from the bran by washing, which caused these differences. In view of the fact that the principal body leached from the bran was a phosphorus compound believed to be phytin, it was inferred that the physiological effects observed were due to this substance, but it was distinctly stated in Technical Bulletin No. 1 that no definite conclusion was reached. Subsequent experimental work conducted by Mr. A. R. Rose corroborated the observations of the former experiments in some particulars, but not in others. The details of this later work are given in Technical Bulletin No. 20.

While there is no doubt but that the leachings from the wheat bran contained substances having marked physiological reactions, we are not yet able to connect these reactions with specific compounds. One of our weaknesses in an attack upon this problem is a lack of definite knowledge concerning the exact nature of the phosphorus-bearing compounds in the various feeding stuffs. At the time of the first experiment, it was believed that the main phosphorus-bearing body of wheat bran was phytin. More recent researches indicate that this is not the case. The investigation of

other feeding stuffs appears to show that while all feeding stuffs contain organic phosphorus compounds, somewhat similar, these compounds differ, as, for instance, the compound in corn meal is phytin, while in cottonseed meal and wheat bran, it is not. Below is a summary of the studies of these phosphorus-bearing compounds up to the present time, which studies are being continued.

In Technical Bulletin No. 19 are reported results of an investigation concerning the chemical properties of phytic acid, particularly as to its salts with inorganic bases. A continuation of this work was reported in Technical Bulletin No. 21. In these bulletins, experiments towards the synthesis of phytic acid are also reported. As it was believed that phytic acid was an ester or complex compound of inosite and phosphoric or pyrophosphoric acid, efforts were made to synthesize the substance by acting on inosite with those acids under different conditions. In these reactions, however, only inosite esters of the respective acids were formed which, although similar to, were not identical with, phytic acid.

Technical Bulletin No. 22 contains a report of the chemical investigation of the organic phosphoric acid of wheat bran. It had been believed previously that wheat bran contained phytin but as only a substance of quite different composition could be isolated, the opinion seems justified that it is not phytin, but a differently constituted compound, which is present in wheat bran.

The importance of cottonseed meal as a feeding stuff and the fact that it is believed to contain some poisonous principle led to an investigation of the organic phosphoric acid present in this material. The results are reported in Technical Bulletin No. 25. It was found that the organic phosphoric acid of cottonseed meal was chemically very similar to phytic acid and, while its physiological effects have not yet been fully studied, it was shown that it does not possess any marked toxic properties.

It should be observed that such physiological studies based largely upon chemical investigations are time-consuming and expensive, but as a matter of fact, they are the only means of reaching the knowledge that is fundamental in animal nutrition. Very

many so-called practical feeding experiments have been carried on, and while these are very useful as a test of theories and of formulæ based upon severer investigation it is safe to say that they will not form foundation material for the science of cattle feeding.

BACTERIOLOGICAL STUDIES.

The science of bacteriology has come to have very definite relations to farm practice in several directions. We now know that soil bacteria are important agents in the preparation of plant food. These organisms are intimately associated with the development of leguminous plants such as alfalfa and clover, and one of the triumphs of modern agricultural science is the inoculation of the soil with bacteria as one essential preparation for the growth of alfalfa and other legumes.

Barn and dairy sanitation, now established on a fairly definite basis, is the outcome of bacteriological investigations; for it is this class of organisms that is responsible for the degradation of dairy products through undesirable and excessive fermentation, to say nothing of the presence of disease germs. The technical processes used in the manufacture of butter and cheese are based upon fermentative changes caused by lactic acid ferments and other forms of germ life.

Progress in bacteriological investigation has to quite an extent been limited by the development of methods of work and the extent of our knowledge of the various classes of bacteria and their reactions. For this reason, it has been found necessary and is still necessary to devote much time to the technics of the laboratory and the study of the various types of organisms irrespective of their economic relations.

Several years ago the Station began a study of the changes which occur in the curing of cheese, changes brought about through the action of ferments, both chemical and bacterial. In making these investigations it was found desirable to suppress the action of one class of ferments or of all ferments in order to discover, if possible, what agencies were operating to cause the

breaking down of the cheese substance. This led to the study of the influence of chloroform in varying quantities not only upon bacteria but also upon the chemical ferments known as enzymes. It also was found necessary to gain a more complete knowledge concerning the classes of bacteria found in fermenting cheese as the first step in gaining some knowledge of the specific action of the several classes. This led to an extensive technical study of cheese flora with the result that a marked advance was made in our knowledge of the various groups of bacteria involved in the problem of cheese curing. These are technical studies which may appear to the unscientific mind as not coming within the limits of practical agricultural investigation, but without which successful investigation along the lines indicated could not be carried on. It should be stated that these cheese studies are not yet completed. It is felt, however, that a large amount of fundamental knowledge has been obtained and the outlook for directly practical results is hopeful.

The bacteriological staff has devoted much time to studies in connection with milk sanitation. In recent years, great interest has been shown in the production for commercial use of milk that is as free as possible from germ life in order that the health of the consumers may not in any way be threatened by unsanitary milk or milk carrying disease germs. There has appeared in the large markets what is known as certified milk — in other words, milk produced at great cost because of the precautions necessary, or regarded as necessary, to reduce the germ content of the milk to a very low figure. Certified milk production, as carried on in some places, has involved the washing of the stable walls, the bathing of the animals, scrupulous neatness on the part of the employees drawing and handling the milk, and great precaution in cooling and bottling of the milk. Such methods have been financially possible only through the disposal of the milk at very high prices. These expensive methods of producing sanitary milk were adopted without any definite knowledge as to the absolute or relative influence of the various factors involved, such as the

trol of the use of the machines, it was found that the bacterial content of the milk remained well below 10,000 per cubic centimeter, ranging in a majority of cases between 2,000 and 5,000. These tests were carried out under ordinarily good barn management and indicate that the milking machine, properly handled, may be made an important factor in the production of sanitary milk.

Another important line of investigation recently instituted by the bacteriological department is the study of soil bacteria, especially as influenced by the application to the soil of lime and other substances. We have come to understand that soil flora are intimately related to fertility and it is well within the range of probability that the effect of lime or other materials applied to the soil may be in part due to a modification of the kind and activities of soil bacteria. This investigation has not proceeded beyond the preliminary steps that are necessary to the carrying on of an extended piece of research.

Vegetable growers have at times met with serious losses from what are known as soft rots. The soft rot of cabbage has received the attention of the Station for some years. It is now known that the causal organism, or group of organisms, is bacterial in its character. As far back as 1902, this Station and the Experiment Station of Vermont entered into a co-operative investigation of the soft rots of cabbage, cauliflower and turnip. This investigation has not proceeded farther than a study of the various strains of organisms related to the soft rots and an attempt at their classification. The knowledge gained forms a basis for further inquiry as to the possible control of vegetable soft rots.

CHEMICAL WORK.

The most laborious and expensive chemical work performed at the Station is the analysis of various materials that are inspected under the authority of the State Commissioner of Agriculture. Samples of fertilizers, feeding stuffs, fungicides and insecticides are selected in the open market by the agents of the Commissioner, which samples are forwarded to the Station for analysis. The an-

nual number of samples of all kinds now analyzed is at least 1600. This work has been increasingly expensive, so far as feeding stuffs are concerned, because of changes in the law requiring not only a chemical analysis, but a determination of the ingredients in the various samples. The results of these various examinations are published annually in the bulletins which are distributed to a list of over 40,000 persons.

The desire is often expressed by dealers and farmers that these analyses might be published each year before it is necessary to purchase these commodities. It is not possible to accomplish this. For instance, samples of fertilizers can not be taken with any economy whatever until the goods for a given year are well distributed in the market. To take samples at the manufacturing establishments would be little short of mockery. This means, then, that sampling will not begin actively until early in March and it is impossible to select a thousand or more samples and secure their analysis before the sale and use of fertilizers begin. The fertilizer bulletins are chiefly valuable in indicating to purchasers those brands of fertilizers that have uniformly been as good as the guarantees, and purchasers may safely bank upon the continued reliability of goods that have been maintained up to their guarantees during a period of years.

At the present time, the feeding stuff trade is a source of perplexity both to the inspecting authorities and the consumer. There are now being placed upon the market many brands of feeding stuffs that are made up in part of inferior materials such as ground corncobs, oat hulls, low grade screenings and the like. Manufacturers are becoming somewhat expert in the use of these inferior materials in such a way as to deceive the purchaser and make difficult their identification. The Station is doing its best to so display the composition of these questionable goods that the consumer will have no difficulty in understanding what he is buying. It is to be feared that farmers are not paying sufficient attention to the published reports setting forth the real character of the proprietary feeding stuffs now in the market. The State is

endeavoring to defend the farmers against fraud and it remains for purchasers to make an intelligent use of the information that is placed in their hands.

Chemical investigation is now related to almost every line of farm practice. At this Institution, much attention has been given to the chemical side of the dairy question. The extensive work which was begun more than twenty years ago, touching the relation of milk to manufactured products, especially cheese, has been largely instrumental in establishing certain standards by which milk of various grades is now purchased for manufacturing purposes. Investigations that were carried on in the earlier days at this Station also threw a good deal of light upon the causes of waste in butter and cheese making. This is all set forth in the Anniversary Report of the Station published January 1, 1908.

More lately, the attention of the Chemical Department has been directed toward the changes which occur in cheese during the process of fermentation. While these changes are almost entirely brought about through the actions of ferments, they must be measured in kind and quantity by chemical methods. These later results, including a determination of the influence of temperature upon cheese curing, are also summarized in the annual report mentioned above.

One of the most important pieces of work undertaken by the Chemical Department since 1907 was an investigation of the composition and economical manufacture of the lime-sulphur wash. This wash has come to have an important place in fruit growing as a means of preventing the ravages of fungus and insect pests. The results of this investigation were embodied in a formula to be followed by the manufacturer such as would accomplish the desired combination of the lime and sulphur without waste. The investigation also provided the data for a more accurate standardization of lime-sulphur washes of varying strengths and for the proper dilution of the commercial preparations when used for various purposes.

An interesting investigation that was carried on by the Chemical Department and one giving results of much promise was the study

of the effect of treating milk with carbon dioxide gas under pressure. Pasteurized milk charged at a high pressure with carbon dioxide was kept for five months with little increase of acidity. Fresh milk similarly treated kept nearly as long in some instances. In view of the fact that carbonated milk is a pleasant beverage and constitutes a healthful drink, this method of keeping it for a long time in a fresh condition makes it possible for this drink to be commonly served during the heated season without loss to the manufacturer.

Other chemical studies essential to the methods of investigating milk and its products have been carried on, such as a volumetric method for determining casein, useful in cheese factories, and a study of the constitution of casein.

A fundamental question in relation to the composition of milk and the various transformations through which milk goes in the manufacture and ripening of cheese is the relation of calcium to casein. This investigation has been carried on for several years. Some new compounds of calcium with casein and paracasein have been found which have important relations to the changes taking place when milk is made into cheese. Not only have calcium compounds been formed and studied but also combinations of casein with sodium, potassium, ammonium, borium and strontium. From the results of the investigations thus far carried on, as summarized in Technical Bulletin No. 26, there appear to be not less than four different compounds of calcium and casein.

CROP PRODUCTION.

It is undoubtedly true that farmers are more or less given to looking for new crops that have unusual properties rather than to attempting improvements in the culture of crops already established. In a majority of instances, the new crops introduced in later years have not proved to have any advantages over those long under cultivation. This is not true of alfalfa, however. The establishment of this plant on the farms of this State marks a notable step in advance in the production of cattle feed. Not

only is the acreage production of nutritive material large, but the alfalfa plant has a distinct value as a soil renovator and as a means of maintaining the necessary nitrogen supply of the farm. There is probably no other instance that can be mentioned in which scientific investigation has been of more marked benefit than in the increase of alfalfa-growing areas.

Leguminous plants, including alfalfa, sustain a peculiar relation to bacteria. Plants of this class act as hosts to certain forms of germ life and unless, for instance, numbers of this bacterium are present in the soil, alfalfa does not flourish. Moreover, the prosperity of this essential bacterium depends very much upon the soil reaction, whether highly acid or not, and so it has been found that the acidity of a particular field needs to be corrected before the soil can be used successfully in alfalfa growing.

For several years, the Bacteriological and Botanical Departments of the Station gave much attention to the conditions favorable to the growth of the alfalfa plant. In a bulletin published in 1908, there is reported the results of experiments in the inoculation of soil for alfalfa growing in 67 fields distributed among 33 counties of this State. It was found that the bacteria, which enable alfalfa to appropriate nitrogen from the air, were almost universally present, but in sufficient numbers in only about one-fourth of the 67 fields to produce the desired inoculation. On 33 of the 67 fields which were tested the application of soil from an old alfalfa field rich in the necessary bacteria changed alfalfa growing from a failure to a success in those particular fields. On 15 fields, a successful crop was produced without this inoculation. This showed beyond question that in many parts of the State soil inoculation is essential to the establishment of the alfalfa plant. Inoculation was but part of the problem; the influence of liming, or the modification of soil acidity, was still to be considered and to what extent liming New York soils was necessary to successful alfalfa production. A bulletin published in 1909 gave the results of more than 100 co-operative experiments in growing alfalfa in about half of the counties of the State.

These observations showed that where neither lime nor inoculation was practiced, the chance of a successful crop of alfalfa was not more than one in five. The addition of lime raised the chance of successful crops to two out of five, and with inoculation alone success was attained in about three-fifths of the trials; but where both lime and inoculation were resorted to, success was attained in four-fifths of the experiments. On the basis of such results, alfalfa growing has developed rapidly in the State and is now an important adjunct to dairy farming in many sections.

Other troubles developed in alfalfa production. One of the most serious of these was the adulteration of alfalfa seed chiefly with the seeds of other legumes such as yellow trefoil, bur clover and sweet clover, and with the seed of dodder. In order to correct the evil of adulteration, the Botanical Department of the Station invited farmers to submit samples of alfalfa seed for examination. Bulletin No. 305 showed that out of 548 samples of alfalfa seed examined, 126 contained dodder. This was an important fact because dodder is a parasitic plant which preys upon alfalfa, clover and other legumes and, if allowed to spread, becomes a source of great loss.

The Botanical Department devised a means of ridding alfalfa seed of the seeds of this pest by the use of a screen which would allow the dodder seed to pass through, but held back the alfalfa. This contrivance was widely advertised. Dodder has now largely disappeared from commercial alfalfa seed in this State.

The examination for the other adulterants mentioned, such as trefoil, led purchasers of alfalfa seed to be cautious in buying, and dealers in seed to be careful concerning what they offered in the market.

Various fungus diseases of the alfalfa plant have been given consideration, but none of these appear to be especially destructive, the most important disease being what is known as leaf spot. It is observed at the Station that in years when there is sufficient moisture this fungus seldom develops to any extent.

DAIRYING.

Dairying is the leading agricultural industry in this State. Dairy products are probably sold from not less than 200,000 farms, involving the keeping of more than a million and a half of cows. The annual sale of dairy products at the time of the last census could not have been less than $60,000,000, and notwithstanding the magnitude of this industry it is unprofitable on many farms, although in many cases this may not be realized. The lack of profit is due to several factors, among which are the low price at which bulk milk is sold and the keeping of inferior cows.

The keeping of careful records of the feeding and production of the Station herd gives an opportunity to illustrate the influence upon profit of the individuality of the animals. The animals in the Station herd present a high grade of efficiency and they are more uniform in their productive capacity than would be the case on any but very exceptional farms. Nevertheless, the range of yield during three years' records was from 3,350 pounds of milk for the poorest cow to 10,150 pounds for the largest yielding cow. This means that one animal produced three times as much milk as the other and twice as much butter-fat, with the consumption by the better animal of only one-tenth more food.

The following is a quotation from the conclusions presented in Bulletin No. 322, published in 1910: "If for the poorer half of the herd, we had substituted animals equal to those in the better half, it would have increased the yearly revenue $237.40 if we had sold milk at current shippers' prices, or $379.90 if we had sold butter-fat, with an added expense of only $40 as the cost of the extra food consumed by the better cows."

As emphasizing the results with the Station herd, mention may be made of the records at the Stations of two farmers, one of whom received in one year $877 from the product of eight cows, while the other farmer received only $868 from the product of twenty-two cows. The Dairy Department of the Station has urged upon the dairymen of the State the wisdom of ascertaining the productivity of the individuals in their herds and the weeding out as fast as possible of the poorer animals.

As previously suggested, one of the questions involved in testing the efficiency of the milking machine was the effect of its continued use upon the yield of milk and the welfare of the animal, especially in the maintenance of the udder in a normal condition. The acquisition of accurate data on this point is difficult. It is not possible to milk the same animal by hand and by the machine throughout the same lactation period, and for this reason it was necessary to determine the yield of milk between two methods with a generous number of animals and through several lactation periods. There was involved in this study not only the effect of machine milking upon yield, but also the question of economy in the use of the machine in the saving of the time of men. The following is a summary of the conclusions given in Bulletin No. 353, reprinted in this report:

One of the limiting factors in the development of the dairy business is the difficulty in obtaining regular and efficient milkers. Interest in the milking machine is largely due to the possibility of displacing a considerable amount of low-grade labor by a single higher grade, better paid man.

This study of the effect of hand and machine methods of milking upon the flow of milk covered over four years. At each succeeding period of lactation the manner of milking was changed so that each cow was alternately milked by machine and by hand during succeeding periods. Satisfactory data were thus obtained from 71 lactation periods.

The normal variation in flow in a large group of cows is at least 1 per ct. The effect of the manner of milking, provided it is thoroughly done, is less than this amount and therefore is not measurable.

In a dairy of 15 cows one man using two machines will milk cows within an average time of 3 minutes but the time lost in preparing and cleaning the machine will equal 1 minute per cow. With larger dairies this latter item will be proportionately reduced.

The Station is now in possession of a herd of milch goats numbering forty-two animals. While the milch goat is not ordinarily thought of as a dairy animal, it is believed that as a source of milk for certain purposes, it will have a place of increasing importance in this country, particularly as a source of food for very young children who are unable to thrive on food of any other kind.

The purpose of keeping this herd is to determine the cost of maintenance, the yield of milk and the uses to which the milk can be put. Very encouraging success has already been reached with infants and young children who were not previously prospering. No results have been published, however, and will not be until data are secured covering a considerable period of time and a large amount of experience in the use of the milk.

The Station has no animals for sale. It will retain all desirable animals and the undesirable ones will be disposed of otherwise.

FRUIT PRODUCTION.

The Experiment Station has devoted a great deal of attention to the interests of the fruit grower. Not only has the Horticultural Department directed its energies almost wholly along this line, but the Departments of Botany and Entomology have been occupied to a great extent with the study and control of the pests from which the fruit grower must be defended. It is quite natural that a generous share of the Station's activities should be directed toward aiding the fruit interests, partly because these are greatly important in this State and are increasing in magnitude, and partly because fruit production has offered definite problems that have been available for study. Moreover, among the fruit growers of the State have been many men who have had the disposition and the ability to co-operate with the Station in the study of their problems.

The Station has made extensive observations as to the character and value of varieties of fruit. This has been accomplished partly by the cultivation of a large number of varieties of several classes of fruit on the Station grounds. The usefulness of variety tests

at a single locality has been the subject of much discussion and, doubtless, much work of this kind has been of little benefit. It is felt, however, that the variety studies at the Station have been of great value. They have provided the foundation data for the preparation of three important publications, "The Apples of New York," "The Grapes of New York," and "The Plums of New York." Other publications are in preparation and contemplated. More than this, the Station has served as a bureau of information, and the members of the Horticultural Department have needed to be in immediate contact with an extensive museum of living fruits in order to speak from actual observation.

The efforts of the Station have not been confined to old varieties, but it has been active in the study of the new fruits that have been offered to the public and has, on its own account, in the course of its breeding experiments, developed a number of new varieties that promise to be of great value. These new varieties include small fruits, such as strawberries and raspberries, as well as grapes and apples. Some of them have been distributed throughout the State for trial by practical fruit growers and so fast as additional varieties seem to be worthy of a more extensive trial, they will also be distributed.

One of the most laborious pieces of work that the Station has ever undertaken was the preparation of the fruit publications referred to above. The collection and organization of the data presented in these volumes has been a work of great magnitude and it is very gratifying that these volumes seem likely to occupy an important place in the horticultural literature of the world. They have been in great demand, much beyond the supply, not only within the borders of the State, but also throughout the United States and in foreign countries. It has not been possible to meet fully the outside demand without doing injustice to local needs, but it has been felt wise to place a limited number of volumes where they would serve to promote the interests of fruit growing in a widespread way. For this reason, other experiment stations, important libraries and a limited number of professional men have been supplied with these publications.

The extensive studies of the fruits of the State made necessary in the preparation of these fruit publications made it possible to prepare bulletins giving advice as to the varieties, particularly of apples, best adapted to the various sections of the State. The bulletin on apple distribution has been much in demand and without doubt has been found to be very suggestive and useful.

The field work of the Horticultural Department of the Station has not been limited to the Station farm although there has been developed on the farm, including the breeding experiments, a collection at one time of approximately 10,000 varieties of fruits, both large and small. In order to study important problems, the Station has acquired the control of several areas of land in various parts of the State. Some years ago, the question of the use of dwarf trees in apple culture was much discussed and in co-operation with a committee of the New York State Fruit Growers' Association, three dwarf orchards of two acres each were established in the State, one in the western portion, one near Syracuse and one in the Hudson River valley. The results of five years' observation has been rather discouraging as to the general value of dwarf trees, considered from the standpoint of acreage production. This type of orchard seems to be promising in the production of a limited number of varieties, such as the McIntosh Red, the Lady, the Wealthy and the Jonathan, particularly the two former. The experiments show, however, that with the most of the leading commercial sorts of apples, standard trees are preferable.

Ten or twelve years ago, a very active controversy developed over methods of orchard management. The merits of cultivation combined with the use of cover crops as against what was termed "sod culture" were warmly debated. This matter being so important, the Station leased an orchard of ten acres which seemed to be well adapted to the pursuit of experimental work for the comparison of the two methods under discussion. Nine years' results have been secured and the work will be continued only one year more. So far as the results of this orchard are concerned, that is located on land typical of large areas in western New York, the verdict is decidedly in favor of cultivation and the use of cover

crops. This outcome is in accordance with the judgment of a large proportion of the best orchardists in the State. It is not claimed on the basis of this experiment that sod culture, so-called, is never advisable; for there are some notable instances of its success where the conditions are somewhat unusual. In some localities, sod culture may be the only feasible method of maintaining an orchard. Notwithstanding all this, the experiment stands as an object lesson to the orchardists of western New York which, if generally heeded, would greatly increase the output of apples and the profits of the grower.

An experiment conducted on the Station farm, which was begun some fifteen years ago, has given results that have attracted wide attention, and the publication of them has caused a great variety of comment. Reference is made to an experiment in growing apple trees to test the influence and economy of applying commercial fertilizers as well as farm manure. The most careful and extensive observations have revealed no more than a hardly appreciable difference between the growth and yield of the trees which were given good cultivation with cover crops but no fertilizer of any kind, and those trees receiving the same culture and liberal applications of fertilizers and farm manure in addition. The statements in the Station bulletin setting forth the facts pertaining to the experiments have been sharply criticised by commercial interests.

As in the case of the experiment in orchard management, so here it is not claimed that fertilizers are never useful in apple production, but it is believed that on large areas of orchard land in the western half of the State, good cultivation and the use of cover crops will abundantly maintain the desired growth and yield of fruit. There are other reasons for the belief that a great deal of money is spent for fertilizers in fruit production which might be saved if the right methods of culture were followed. The members of the Station staff are bound to set forth honestly, and so far as it is in their power, judicially, the results of the experimental work which they carry on. No amount of prejudice

will brush away facts. Caution should be exercised, however, as to making too broad an application of local observations.

During the year 1912, several bulletins have been published by the Horticultural Department, a summary of the main facts and conclusions therein presented being given below:

Influence of crossing in increasing the yield of the tomato.— Bulletin No. 346 shows that an infusion of new blood obtained by crossing closely related varieties of tomatoes increases the vigor of the plant and the yield of fruit to a marked degree. It is uncertain, from the experiments carried on, whether the stimulating effects of the crossing are due to an increase in size or in number of cells. The results obtained seem to warrant the crossing of tomatoes not only by growers but by seedsmen who wish to furnish the best grade of seed. The production of such seed would, of course, require time and care and the seed would have to be sold at higher prices. Recommendations are given for making tomato crosses and also suggestions as to how new characters may be obtained and maintained. Other field or garden crops are named that are thought capable of improvement by crossing.

An experiment in breeding apples.— There have been few efforts to improve apples, nearly all varieties having come from chance seedlings. With the knowledge of recent discoveries in plant-breeding we ought to breed this fruit more advantageously than in the past. Bulletin No. 350 is a record of an experiment in breeding apples in the light of the new knowledge. The material for this experiment came from 148 crosses made in 1898 and 1899. Grafted trees of these crosses began to bear in 1904 and the seedlings came in fruiting in 1908. The crosses have been studied from both the grafts and seedlings, the orchards having had the care usually given commercial plantations.

The crosses which have fruited, with the number of each, are: From Ben Davis X Esopus 4; from Ben Davis X Green Newtown 13, from Ben Davis X Jonathan 11, from Ben Davis X McIntosh 11, Ben Davis X Mother 20, from Esopus X Ben Davis 29, Esopus X Jonathan 2, McIntosh X Lawver 1, Ralls X Northern Spy 9, Rome X Northern Spy 1, and Sutton X Northern Spy 5. These seedlings show marked vigor and are healthier and more

productive than others from self-pollinated seeds, of which considerable numbers are growing at the Station, comparable in age to the crossed seedlings. Contrary to the usual belief, these seedlings have not "reverted to the wild," but show to a marked degree the characteristics of the parents. So evident is the inheritance of parental characters that one familiar with the varieties crossed could in most cases select the parents for individual seedlings. Indeed, so surprisingly uniform has been the transmission of the good qualities of the selected varieties that the fruit of 14 of the 106 fruiting seedlings is considered as good or better than either of the parents, and the trees are satisfactorily productive. These seedlings have been named from counties in New York State and are already distributed to some extent among apple growers.

Grape stocks for American grapes.— Bulletin No. 355 is the report of an experiment in grafting grapes on roots of several species with the hope of improving the viticulture of New York. The experiment was tried with 19 varieties each having some weakness which it was hoped could be overcome by grafting on one of three different stocks. The vines passed through many vicissitudes during the ten years the test was carried on, but despite these it was evident throughout the experiment that the grafted grapes surpassed those on their own roots. The grafted vines were most productive and showed greatest vigor. The grapes on the grafted vines ripened a few days earlier than those on their own roots. The experiment suggests that it would be profitable to grow some of the fancy grapes of this region on grafted vines and that it is well within the bounds of possibility that main-crop grapes can be profitably grafted. It is recommended that grape growers try small vineyards of grafted grapes, using as stocks the three tried in this experiment.

Pedigreed nursery stock.— Circular 18 from this Department holds that there is but slight foundation for the claims of nurserymen and fruit growers who advocate propagating trees only from buds taken from selected trees. The assertions that trees propagated from selected stock are better than those taken from other trees of the same variety far outstrip the evidence. To attempt

putting in practice the reform demanded would revolutionize nursery practice — sheer folly without real, precise, abundant evidence of good to be accomplished. The chief defense of the position taken in the circular is that the variations commonly found in trees are fluctuating ones due to environment and are not, unless in very exceptional cases, transmissible. It must be proved that a character of any particular tree is transmissible before it will be worth while propagating for that character.

INJURIOUS INSECTS.

The efforts of the Entomological Department of the Station have been devoted largely to the defense of the farm and orchard against insect pests. This has involved not only a study of the means of preventing the ravages of well-known insects, but also an investigation of the life history of new forms of insect life with a development of the means of preventing the injuries they would cause.

The insects of which the life history has been studied during the last five years, in part through laboratory investigation, and in part through field observations, are the following: The poplar and willow borer, leaf-blister mites, the tussock moth, grape-leaf hopper, the fidia or root worm, tree hoppers, the ermine moth and the pear thrips. The important better known insects with which this Department has dealt are the San José scale, the cabbage maggot and the pear psylla.

With the newer insects, the following results have been secured: The studies of the poplar and willow borer resulted in recommending the cutting out and destroying in June of the parts affected with the grubs and, in addition, spraying during July with bordeaux mixture containing an arsenical poison.

The ravages of the leaf-blister mite have been general throughout the apple-growing areas of western New York. Experiments demonstrated that the lime-sulphur wash, oil emulsions and miscible oils are efficient remedies for this pest. It is found that orchards regularly sprayed with any of these mixtures are not

subject to injuries by the mite. Generally one application of either of these sprays has prevented the spotting of the foliage.

The caterpillars, or larvæ, of the tussock moth damage young apple and pear fruits. This pest seldom appears in destructive numbers. When it does, the egg masses should be collected and destroyed and arsenical sprays should be used to prevent devastation by the caterpillars.

The very serious pest in the grape regions of New York, especially in Chautauqua county, is the grape leaf hopper and the results of our experiments appear on the following pages in a summary of Bulletin No. 344.

The ermine moth, an insect of somewhat recent importation, and the pear thrips, an insect very destructive in certain sections of the State, especially in the Hudson River valley, have also been studied and the results of the investigations and experiments appear later in the summaries of Technical Bulletin No. 24 and Bulletin No. 343.

In view of the fact that cabbage growing is an important industry in this State, much attention has been given to insects attacking the cabbage plant, particularly the turnip flea beetle and the cabbage maggot. An efficient prevention of the depredation of these insects, particularly the maggot, was found in the screening of cabbage seed beds with cheesecloth. This method of growing the young plants conserves the moisture in the bed, raises the temperature and furnishes congenial conditions for growth so that plants under cloth start sooner, grow faster and reach the desired size a week or ten days earlier than plants in the open. Moreover, this screening completely protects the seedlings from maggot injury with the result that the growing crop is not injured by this insect. It was found, also, that certain grades of cheesecloth would prevent injury by the flea beetles.

Some seven years ago the apple growers of the State were greatly concerned over the spread and destructive effects of the San José scale, an insect that first made its appearance in this country in California, and through the distribution of nursery stock and by other means, has spread over a large portion of the

fruit growing regions. Even some of the more intelligent apple growers nearly concluded that they would be obliged to give up apple growing. It was feared that in the case of large trees no means of preventing the destructive effects of the scale could be devised. There was laid upon the Station the imperative duty of giving to this insect a large amount of attention, for it was true that unless some means could be found of minimizing its destructive effects an end to apple growing in the State of New York would inevitably come. Investigations in regard to the use of various spraying liquids were begun at this and other stations with the result that today the San José scale is no longer feared as a menace to fruit growing. This Station was able to demonstrate in an orchard at Youngstown, N. Y., that large trees already badly affected could be restored to a productive condition and so maintained. It has been finally concluded that no spraying liquid is equally efficient with the lime-sulphur wash, and the fruit growers of the State have been put in possession of the details of manufacturing for themselves this wash in an economical way and at much less cost than is involved in the use of commercial preparations. It is not too much to claim when it is stated that this one service to the fruit-growing interests of New York has repaid the State many times over for the cost of the scientific agencies that are now working in the interest of the farmer.

The pear thrips.—In Bulletin No. 343 the attention of fruit growers is called to the discovery of the pear thrips (*Euthrips pyri* Daniel) in the Hudson River valley. The occurrence of the pest in New York is of special interest as this is the only region in the United States, outside of the heretofore recognized area of infestation in California, where the thrips is known to exist.

It is noted that in its appearance and habits the thrips is quite different from all other insects which growers in this State have been accustomed to combat. The adult, which is largely responsible for the injuries to the trees, is a small, darkish brown, winged insect measuring about one-twentieth of an inch in length. It appears in destructive numbers when the buds are opening, attacking the tenderest of the flower parts. The eggs are mostly

deposited beneath the epidermis of the blossom and fruit stems. Hatching takes place in a few days and the larvæ seek preferably the calyx cups, undersides of calyces, and the folds or under surfaces of the tender, expanding leaves. The larvæ feed for about two weeks and drop to the ground, in which they form a protecting cell. In this cell the insect completes its transformations and emerges from the ground in the spring as an adult. The thrips is single brooded, and the most active and destructive stages are coincident with the period that includes the life events of the swelling and opening of the buds and dropping of blossoms and calyces. If the thrips are numerous the injured buds of pear trees become sticky with a brownish liquid and cease to develop, while the blossom clusters have a stunted, shriveled and brownish appearance as if blasted. Apple trees, while visited by large numbers of the adults, suffer to a much less extent, but dwarfed and curled leaves and occasionally stunted fruits may be observed in most orchards. The stems of sweet cherries are especially attractive to the adults for the deposition of the eggs, and as a rule they show considerable scarification. The effects of this injury on fruit yields was not ascertained.

During 1911 the actual range of the distribution of the thrips in this State was not determined. It was quite destructive to pear orchards generally about North Germantown, Germantown and Cheviot, and there were reasons for believing that the pest was distributed over a large area of the Hudson River valley. In western New York specimens of the insect were found on apples growing about Geneva.

A brief report is given of experiments to develop efficient methods of control. Spraying with nicotine extract in combination with kerosene emulsion or soap when buds are breaking and until they are entirely opened is the most promising means of protecting the trees.

The grape leaf-hopper and its control.— This Bulletin, No. 344, is a report of the life-history studies on this insect and of various experiments to devise an effective and safe insecticide for the protection of grape vineyards. Considerable emphasis is

placed upon the effects of the destructive work of the insect upon the quality of the fruit, as well as on the yields, which has not been fully appreciated by growers generally. It is shown that the grape leaf-hopper feeds by sucking, and preferably on the under sides of the leaves. It pierces the skin of the leaf, feeds until satisfied and then withdraws its proboscis or sucking tube, thus leaving an opening from which the plant juices dry out, not only from the pierced cell but from adjoining ones. There is soon formed about each puncture a spot of dead tissue. When the insects are superabundant there is a severe drain on the vitality of the leaf and it takes on an unhealthy yellow hue. The death of so many starch-making cells lessens the amount of wood produced and of fruit formed; and seriously affects the quality of the fruit, making it ill-flavored or sour and poorly colored. The rich blue-black of the Concord becomes a lifeless reddish color while the attractive flavor may be lost so that grape-juice makers and most buyers of grapes for the table reject the fruit.

Brief descriptions are given of a number of spraying experiments which showed that a spray containing two one-hundredths of 1 per ct. of nicotine (Black Leaf 40, one gallon to sixteen hundred gallons of water) is the most effective and safest insecticide for the control of this pest. The bulletin concludes with general directions for spraying. The application of the mixture can be done by the usual hand-spraying with trailing hose or by an automatic leaf-hopper sprayer which is completely described. The latter device was developed during the year's work and has proven most satisfactory. With high pressure and the proper adjustment of the nozzles almost complete protection has been afforded to a number of commercial vineyards.

The apple and cherry ermine moths.— In Technical Bulletin No. 24 attention is called to the occurrence of these insects in the United States and to their economic importance as fruit pests. These insects were introduced in shipments of foreign nursery stock and appeared in plantations of apple and cherry seedlings. It is stated that since the insects were first detected in 1909 special precautions have been taken by the agents of the Division of

Nursery Inspection of the New York Department of Agriculture with plantings of foreign-grown seedings, and during the past four years infested plants have been collected in thirteen localities in the State.

A report is given of life-history studies on some of the insect material which was forwarded to this Station for identification. Two species of moths were bred — *Yponomeuta malinellus* Zell., which thrives largely on apple and *Y. padellus* L., which is a more general feeder, showing preference for hawthorn, plum and cherry. Both species are common and destructive fruit insects in Europe. The bulletin closes with a discussion as to the rôle these insects are destined to play as fruit pests in the United States. Careful inspections of nursery plantations and the surroundings of nurseries indicate that these lepidopterons have not gained a footing in New York. In states where there has not been such inspection the danger that such has taken place is obviously great. With the ability of these insects to survive the conditions incidental to the importation of nursery stock from abroad and to escape ordinary nursery inspection, the wonder is that they have not before this succeeded in establishing themselves along the avenues of trade in America.

PLANT DISEASES.

The annual loss to the agriculture of New York from the devastations of fungus and other plant diseases is very large. These diseases are in the nature of parasites living upon such hosts as fruit trees, the potato and other important agricultural plants. Their successful prevention is often very difficult and, in some cases, practically impossible, for the treatment that would be severe enough to destroy the fungus would also be fatal to the host.

Economically considered one of the most important pieces of work carried on by the Botanical Department has been the so-called ten-year experiments in spraying potatoes. Before this experiment began, it was known that the proper application of the bordeaux preparation would practically control potato blight.

It was not definitely determined that annual spraying would be profitable during a series of years because the blight does not attack the potato plant every season and when this disease is not prevalent, spraying is less necessary. The year 1911 was the tenth year of this experiment and there follows later a summary of the results, showing that the average results for the ten years indicate a material net profit from the annual spraying.

During recent years, the attention of the Station has been called to a very prevalent disease of fruit trees known as the "crown rot." In all sections of the State much loss has been caused by this affection. Various explanations have been offered, such as the attack of a fungus, and arsenical spraying. Extended investigations by this Station have led to the conclusion that this disease (if it may be called such) is due chiefly to winter injury. An account of the investigation is given in Technical Bulletin No. 23 of which a summary is given on p. 561.

The Botanical Department of the Station has demonstrated its usefulness in maintaining a very careful survey of the plant diseases prevalent in the State. As an illustration of the value of the watchfulness that has been maintained, this Department first called attention to the existence of the currant rust in this country, doubtless imported from Europe. This disease caused great damage to pine forests in other countries and it has been found necessary to destroy thousands of imported pine trees that were affected with this pest. More recently, it has been found that the currant rust is now well distributed in portions of New York in currant plantations and this matter will require the most careful attention by the State to prevent serious loss from its possible spread to our pine forests.

The Botanical Department has also been asked to advise in the matter of controlling that most destructive disease, the chestnut blight, which is causing the death of large numbers of chestnut trees, particularly in Pennsylvania and in certain sections of New York. The head of this Department has united with other specialists in urging that much more study must be given to the life history of the disease and to the manner in which it is spread

before we shall be in a position to enter upon an active campaign for the purpose of preventing further injury.

Several new diseases have been studied, particularly diseases of the raspberry and the currant, and while no means has been discovered for preventing the blight affecting these two classes of plants, a foundation knowledge has been laid for further efforts.

For several years, the Station has consented to the inspection of samples of seeds sent in by farmers. The opportunity thus offered has been utilized by very many persons. The Legislature of 1912 passed a seed inspection law, which throws upon the Station the duty of examining all samples of seeds sent to it officially by the Commissioner of Agriculture. Later may be seen a summary of the work accomplished during 1911 as given in Bulletin No. 345. During 1912 a larger number of samples have been examined because of the legislation before mentioned.

Seed testing.— During 1911, 1,015 samples of agricultural seeds were tested for purity. Dodder was found in 12.9 per ct. of the alfalfa samples and 4.74 per ct. of the red clover samples. Two samples of red clover and twelve of alsike clover were found to be adulterated. Many samples of alfalfa contained seeds of Russian thistle and roquette, but these weeds are quite harmless in New York. The bleaching of oats by means of sulphur fumes injures their germination. Several failures in oat seedlings were found to be due to this cause. Full details of the seed work have been published in Bulletin 345.

Potato-spraying experiments.— The series of experiments designed to determine the profit from spraying potatoes was closed in 1911 and the results published in Bulletin 349. These experiments demonstrate beyond doubt that the spraying of potatoes is highly profitable in New York.

In the so-called ten-year experiments, the ten-year average increase in yield is as follows:

At Geneva, three sprayings, 69 bushels per acre.

At Geneva, five to seven sprayings, 97.5 bushels per acre.

At Riverhead, three sprayings, 25 bushels per acre.

At Riverhead, five to seven sprayings, 45.7 bushels per acre.

In the farmers' business experiments (6 to 15 each year) the nine-year averages are as follows:

Increase in yield, 36.1 bushels per acre.

Total expense of spraying, $4.74 per acre.

Net profit from spraying, $14.43 per acre.

In 1911, the Station made a comparative test of lime-sulphur, lead benzoate and bordeaux mixture for spraying potatoes. The results of the experiment plainly show that neither lime-sulphur nor lead benzoate can be profitably substituted for bordeaux in spraying potatoes. Both lack the stimulative influence possessed by bordeaux while lime-sulphur also dwarfs the plants and lowers the yield. A repetition of the experiment in 1912 gave similar results. For details of these experiments see Bulletins 347 and 352.

Crown-rot of fruit trees.— Crown-rot is a disease of trees in which patches of dead bark or bare wood occur on the trunk near the surface of the soil. An extended investigation of this disease shows that it is due chiefly to winter injury. It is most liable to occur on trees in wind-exposed situations, particularly on those which have made very rapid growth and gone into the winter with their wood unripened. Hence, it appears probable that it may be at least partially prevented by planting the varieties which are least susceptible, providing windbreaks, heading low, avoiding excessively rapid growth and inducing early ripening of the wood, In order to prevent trunk rot which often follows the initial injury the areas of dead bark should be detected and treated as early as possible. The trunks of young apple trees should be carefully examined twice a year — May and July. Wherever dead bark is found it should be carefully cut away, the wound disinfected with a 1 to 1,000 solution of corrosive sublimate and then covered with grafting wax or gas tar to keep out moisture and induce healing. A full account of the investigation is given in Technical Bulletin 23.

PLANT NUTRITION.

The only work in plant nutrition, the results of which have been published during the past five years, is a report of experiments

on Long Island to test the comparative merits of methods of application of fertilizers and the efficiency of the various forms of nitrogen. These tests showed little difference in the efficiency of organic nitrogen from dried blood as compared with inorganic nitrogen from nitrate of soda. It was noticed, however, that where there was sufficient rainfall, there was a more rapid growth of vines from the nitrate of soda. As to the manner of application, there appeared to be a small difference in favor of distributing the fertilizer in rows. The advantage was slight, however. These tests ratify much more extended experiments made some years ago in showing that when fertilizers are used in excess of 1,000 lbs. per acre, there is not a corresponding increase of yield and either practically no profit or a loss.

During the past sixteen years, there have been maintained on the Station farm, fertilizer experiments having for their object a comparison of certain methods of maintaining soil fertility. No reports have yet been made of this work, but after harvesting a crop of 1913, the results for this long period of time will be made public.

POULTRY PRODUCTION.

While but little has been published in recent years from the Poultry Department of the Station, work has been going on steadily chiefly along breeding and nutrition lines. This work is of such a nature that it is necessary to continue it for a long period of time in order to get results that are reliable and upon which conclusions can be based.

PUBLICATIONS ISSUED DURING 1912.

BULLETINS.

No. 343. January. The pear thrips. P. J. Parrott. Pages 28; color plate 1, plates 4, figs. 5. Popular edition, pages 6, plate 1.

No. 344. February. The grape leaf-hopper and its control. F. Z. Hartzell. Pages 15; plates 4, figs. 3. Popular edition, pages 5, plates 1, figs. 2.

No. 345. February. Seed tests made at the Station during 1911. G. T. French. Pages 14. Popular edition, pages 3.

No. 346. March. Influence of crossing in increasing the yield of the tomato. Richard Wellington. Pages 20. Popular edition, pages 6.

No. 347. March. A comparative test of lime-sulphur, lead benzoate and bordeaux mixture for spraying potatoes. F. C. Stewart and G. T. French. Pages 14; plates 4. Popular edition, pages 1.
No. 348. May. Analyses of materials sold as insecticides and fungicides. Pages 14.
No. 349. June. Potato spraying experiments, 1902–1911. F. C. Stewart, G. T. French and F. A. Sirrine. Pages 41. Popular edition, pages 9.
No. 350. June. An experiment in breeding apples. U. P. Hedrick and Richard Wellington. Pages 46; plates 17. Popular edition, pages 10.
No. 351. September. Inspection of feeding stuffs. Pages 131.
No. 352. November. Lime-sulphur vs. bordeaux mixture as a spray for potatoes. M. T. Munn. Pages 7; plate 1. Popular edition, pages 1.
No. 353. November. Milking machines: Effect of machine method of milking upon the milk flow. G. A. Smith and H. A. Harding. Pages 35; plate 1, fig. 1. Popular edition, pages 9.
No. 354. November. Report of analyses of commercial fertilizers collected by the Commissioner of Agriculture during 1912. Pages 120.
No. 355. December. Grape stocks for American grapes. U. P. Hedrick. Pages 32; plates 5. Popular edition, pages 8.
No. 356. December. Director's report for 1912. W. H. Jordan. Pages 48.

TECHNICAL BULLETINS.

No. 19. April. Phytin and phosphoric acid esters of inosite. R. J. Anderson. Pages 15.
No. 20. May. A study of the metabolism and physiological effects of certain phosphorus compounds with milch cows, II. A. R. Rose. Pages 30; figs. 4.
No. 21. June. Phytin and pyrophosphoric acid esters of inosite. II. R. J. Anderson. Pages 14.
No. 22. September. The organic-phosphoric acid compound of wheat bran. R. J. Anderson. Pages 14.
No. 23. September. Crown-rot of fruit trees; field studies. J. G. Grossenbacher. Pages 57; plates 23.
No. 24. November. The apple and cherry ermine moths. P. J. Parrott and W. J. Schoene. Pages 40; plates 9, figs. 10.
No. 25. December. The organic phosphoric acid of cottonseed meal. R. J. Anderson. Pages 10.
No. 26. December. Composition and properties of some casein and paracasein compounds and their relation to cheese. L. L. Van Slyke and A. W. Bosworth. (In press.)

CIRCULARS.

No. 18. February. Pedigreed nursery stock. U. P. Hedrick. Pages 8.
No. 19. February. Grape culture. F. E. Gladwin. Pages 8.

New York Agricultural Experiment Station,
Geneva, N. Y., December 31, 1912.

W. H. JORDAN,
Director.

REPORT

OF THE

Department of Animal Industry.

W. H. JORDAN, *Director.*
H. A. HARDING, *Bacteriologist.*
G. A. SMITH, *Dairy Expert.*
R. J. ANDERSON, *Associate Chemist.*
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REPORT OF THE DEPARTMENT OF ANIMAL INDUSTRY.

MILKING MACHINES: EFFECT OF THE MACHINE METHOD OF MILKING UPON THE MILK FLOW.*

G. A. SMITH AND H. A. HARDING.

SUMMARY.

1.— The milking machine is of interest mainly because of the labor problem. Using two machines one man can milk fifty cows.

2.— This study of the influence of hand and machine methods upon the flow of milk covers a period of over four years and includes 71 lactation periods after eliminating the questionable data.

3.— The influence of the machine method of milking upon the flow of milk was too small to be measured even when the other factors were eliminated as fully as possible. It was probably responsible for less than 1 per ct. of the variation in flow under the conditions of this experiment.

4.— All of the cows milked well with the machine when they were provided with properly fitting teat cups. Two cows which were failures with hand milking were successfully milked by the machine.

5.— Machine milking has proven practicable. The problem now is to develop the machines along most helpful lines and to learn to handle them most efficiently.

INTRODUCTION.

In practically all branches of farming the high price and scarcity of labor have been met by the use of labor-saving machinery. Hand milking of cows is still the ordinary method but the difficulty of getting efficient hand milkers is one of the limiting factors in the development of modern dairying and there is an insistent demand for milking machines.

Milking by machines is not a new idea. Many types of machines have been tried and pronounced worthless. Accordingly the question is being constantly asked, Are the machines at present on the market a success? Manifestly there is no specific answer to such a general question. Automobiles are generally

* A reprint of Bulletin No. 353, November, 1912; for "Popular Edition," see p. 851.

considered a success though many find them both troublesome and expensive and there are wide differences in quality among the various makes. It is probable that the various milking machines now on the market are likewise of unequal efficiency.

The studies of milking machines at this Station were begun in 1906 with a Globe machine, which was found to be unsuccessful in practically every particular. This was replaced in the spring of 1907 by the Burrell-Lawrence-Kennedy milker, which has been in constant use since that time. The results given in this bulletin are those obtained with this latter machine.

Since the accurate study of a milking machine requires that it be under observation for a considerable time it is manifestly impossible for this Station to test all of the various makes which are upon the market. On the other hand all milking machines fall into one of two general classes: (1) Those which mechanically force the milk from the teat after the manner of hand milking, and (2) those which depend upon the action of a vacuum producing an effect similar to that of the mouth of the calf. The machine which was used in these studies was a representative of the latter class. While the basic principles involved in the operation of these machines are few they are not identical in the two types and accordingly the results here obtained may not all apply to machines of the other class.

While some representatives of the teat-compressing milkers are in use in this country all of the tests of milking machines thus far reported, with the exception of those of the "Murchland" and "Thistle" at Guelph, have been made with the same class and make of milkers as that used in these studies. Therefore the results obtained here and at the other experiment stations are fairly comparable.

In Bulletin 317[1] were presented the results of our studies of the effects of methods of handling milking machines upon the

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[1] Harding, H. A., Wilson, J. K., and Smith, G. A. Milking machines: Effect of method of handling on the germ content of the milk. N. Y. Agr. Exp. Sta. Bul. 317, 1909; also N. Y. Agr. Exp. Station Ann. Rpt. 28 (1909): 56–95. 1910.

germ content of the milk. While the present publication presents observations upon some other economic aspects of milking machines, it is principally concerned with influence of the machine method of milking upon the flow of milk.

PREVIOUS WORK.

The milking machine appears to have first gained an extensive foothold in Australia,[1] and McMillan[2] states that the Hawkesbury Agricultural College at Richmond, N. S. W., has used such machines continuously in its dairy since about 1902. He gives the comparative yields of eight cows during two-week periods in which they were milked by the machine and by hand, respectively, but these results do not show that the machine exerts any influence on the flow. He also states that after using the machine for nine years on some cows through five lactation periods no objectionable results were evident.

The earliest studies of milking machines at an American experiment station were probably those made at Guelph,[3] Canada. The "Murchland," a suction, non-pulsating machine, was tried in 1895 but soon pronounced a failure. In 1898 the "Thistle"[4] a combined suction and squeezing machine, was tested and rejected because of the difficulty of cleaning it. During 1906 the Burrell-Lawrence-Kennedy machine was studied, and comparisons made between yields from cows milked during alternate periods by the machine and by hand. The number of cows ranged from 5 to 15 during the different periods and the test periods were

[1] Wicken, P. G. Milking machines. *Jour. Dept. Agr. W. Aust.* **13**: 301–3, 1906; cited from *Expt. Sta. Rec.* **17**: 1182. 1906.

Suter, P. H. The milking machine. *Jour. Dept. Agr. S. Aust.* **8**: 658–61, 1905; cited from *Expt. Sta. Rec.* **17**: 180. 1905.

[2] McMillan, J. G. Machine vs. hand milking. *Agr. Gaz. N. S. Wales.* **22**: 859–68, 1911; abs. in *Expt. Sta. Rec.* **26**: 274. 1912.

[3] Dean, H. H., and Edwards, S. F. Milking machines. Ont. Dept. of Agr. Bul. 159. 1907.

[4] Harrison, F. C. Machine-drawn milk vs. hand-drawn milk. *Cent. Bakt.*, II Abt., **5**: 183–189. 1899.

from 10 days to 1 month long. The average results were in favor of hand milking in all the tests except one.

Erf[1] traced the history of the development of milking machines and states that "From a series of thirty-two tests to compare the thoroughness of milking it was found that the average cow milked by a machine is milked slightly cleaner than by average hand milking." He does not give his data nor state the duration of these tests but the context suggests that they were of brief duration.

Lane[2] gave the results of a 30-day test of a milking machine on two farms. The comparison was made by milking cows by hand and by machine during alternate 10-day periods. On a farm where the cows had been milked with a machine for about three years a slightly larger flow was obtained by the machine. On the second farm where the machine had been used a shorter time slightly more milk was obtained by hand milking.

Beach[3] studied the effect of a milking machine during nine weeks and contrasted the observed shrinkage with that found with hand milking. The shrinkage when the machine was used was slightly larger than that observed with other cows by hand milking.

Mairs[4] divided 10 cows into two equal lots, one being milked by hand and the other by machine. At the end of four weeks the manner of milking each lot was reversed. The experiment was continued 16 weeks, changing the manner of milking at the end of each four weeks. He states that "No difference in yield of milk was observed that could be attributed to the milking machine, but there was usually a slight drop when changing from one method to the other, always in changing from hand to machine milking."

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[1] Erf, O. Milking machines. Kan. Agr. Exp. Station Bul. 140. 1906.

[2] Lane, C. B. Practical studies of a milking machine. U. S. Dept. Agr., B. A. I. Bul. 92. 1907.

[3] Beach, C. L. Milking machines. Part II. Effect upon milk yield. Conn. (Storrs) Sta. Bul. 47. 1907.

[4] Mairs, T. I. Test of a mechanical cow milker. Penn. Agr. Exp. Station Bul. 85. Jan. 1908.

It will be noted that each of the above comparisons was made on the basis of short-period tests of the two methods of milking and in practically all cases the cows used in these tests were not accustomed to milking machines. All of these workers have been familiar with the fact that cows are adverse to changes in their habits and decrease their milk flow when changes are instituted. They adopted this unsatisfactory method of experimentation with a recognition of its limitations because they were making preliminary explorations of a new field and did not think it wise to risk their animals on longer experiments until the safety of the procedure had been fairly demonstrated.

While Price[1] did not conduct any short time experiments on this subject he reported observations from an 18-months' use of the milking machine. Contrasting the yields with machine milking with those previously obtained by hand he concluded that "Some cows give more milk by machine milking and others less. Present knowledge indicates that machine milking is as efficient as hand milking under average conditions."

The futility of short time experiments was strongly emphasized by Haecker and Little.[2] They conducted a number of trials of this kind and concluded that "The two methods of milking are so radically different in operation that when the milker was substituted for hand labor the cows did not milk out completely. The amount of strippings increased as the experiment progressed, plainly indicating that the method (of experimentation) was detrimental." They also gave the yield from 20 cows milked through an entire lactation period with the machine and in the case of 11 cows contrasted these results with the yield from one or more lactation periods with hand milking. With 10 of the 11 cows the yield with machine milking was less than the average of the available records of the particular cow. In a number of instances the decrease was quite marked.

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[1] Price, Jas. N. Home grown rations in economical production of milk and butter. Tenn. Agr. Exp. Station Bul. 80. June 1908.

[2] Haecker, A. L., and Little, E. M. Milking machines. Neb. Agr. Exp. Station Bul. 108. Dec. 1908.

Woll and Humphrey[1] gave the results of a study of the milking machine extending from October, 1906, to July, 1908. Twenty-nine cows were milked for periods varying from 4 to 76 weeks. The influence of the milking machine was deduced mainly from the rate of shrinkage as contrasted with other hand-milked cows and this data was checked in a measure by comparisons with the yield of the same cows at corresponding periods of previous lactations when they were hand milked. They concluded that " The figures for the average weekly decrease in production for cows kept under similar conditions as these, except that they were milked by hand, has been found to be identical with these, viz., on the average, 2.9 pounds of milk and 0.12 pounds of fat. There is, therefore, no difference between the results obtained by hand milking and the average data given in the table for machine-milked cows." Contrasting the results obtained by machine milking with the yields obtained in corresponding periods of lactation from the same cows when milked by hand they say: " These results agree so closely that they may be considered identical for all practical purposes."

The main difficulty in measuring the effect of any method of milking lies in the fact that a cow can be milked by only one method at a time. It has been shown that if the method of milking is changed frequently the change itself becomes a disturbing factor which destroys the value of the comparison. This difficulty was reduced but not avoided in the Pennsylvania and Wisconsin experiments by making the periods relatively long. These objectionable results would seem to be minimized by making the lactation period the unit of comparison as was done in the Nebraska studies. However the use of the lactation period in this way involves the fact that the production of a cow during any period is influenced by a number of factors in addition to the manner in which she may be milked. Assuming that her feed

[1] Woll, F. W., and Humphrey, G. C. The efficiency, economy and physiological effect of machine milking. Wis. Agr. Exp. Station Research Bul. 3, 1909; also Milking machine experiments. Wis. Agr. Exp. Station Bul. 173. 1909.

is carefully controlled the most important disturbing factors are her health, length of the interval between lactation periods and her age. These difficulties in obtaining an accurate measure of the influence of machine milking can be best met by studying the effect on a number of cows for several years, arranging the details so as to neutralize the disturbing factors so far as possible.

THE MILKING MACHINE.

The Burrell-Lawrence-Kennedy milking machine arranged for milking two cows simultaneously, as it appeared during the latter portion of these experiments, is shown in Plate I. Its most important elements are the portions within which the milking is actually done — the funnel-shaped teat cups which surround and support the teats. These are shown in the illustration, supported by the handle of the pulsator in a manner convenient for carrying about the stable. The large upper ends of the teat cups are provided with rubber curtains which prevent the entrance of air at that point when the cups are on the teats. The small lower ends are connected with the pail by rubber tubes. The vacuum within the pail is transmitted through these tubes to the teat cups and the milk as it comes from the teats flows through these tubes to the pail. A vacuum of approximately one-half an atmosphere is maintained in a reservoir by an air pump and this reservoir is connected with the pail by suitable piping.

When the milking machine has been connected with this vacuum reservoir and placed in operation a mechanism on the cover of the pail automatically interrupts the connection between the vacuum reservoir and the teat cups about once per second, the exact rate being under the control of the operator. During the brief period in which the vacuum acts upon the teat the muscle at the end of the teat relaxes and the milk in the teat flows out into the tube at the base of the teat cup. During the alternate periods in which the vacuum is interrupted the opening at the end of the teat closes and the teat refills from the milk cistern above it.

OUR OWN STUDIES.

Logically the first step in studying any machine is to become familiar with its manner of operation. Accordingly, for some months, the authors personally attended to the daily milking of a number of cows with the milking machine. After they became familiar with the details of its working the barn foreman was likewise carefully trained in the work. Before undertaking the studies of the Burrell-Lawrence-Kennedy machine in 1907 the barn foreman spent two weeks in the private dairy of the manufacturer acquainting himself with all of the points peculiar to the manipulation of this machine. At the time of installing the machine and on a number of subsequent occasions we have had the advantage of advice and instruction from the company's representatives who have been skilled in the operation of the machine. Throughout these studies the aim has been to operate these milking machines in accord with the directions furnished by the manufacturers except in so far as it was necessary to depart from these in the study of some particular phase of the milking machine problem.

These studies have been complicated by the fact that, though but one make and type of machine has been under investigation during the five years, the machines themselves have been undergoing marked changes. The sum total of these changes has been so great that the milking machine of 1912 bears little resemblance to that of 1907.

The problems connected with the milking machine are too numerous and too complicated to be solved by any single line of experiments or within a short period. During the years in which the present machine has been continuously under observation information has been accumulated regarding several phases of the question. While it is the aim of this publication to discuss the relation of the machine method of milking to the yield of the cow it seems desirable here to summarize, at least, the other observations, especially as some of them are intimately related to the larger question of milk flow.

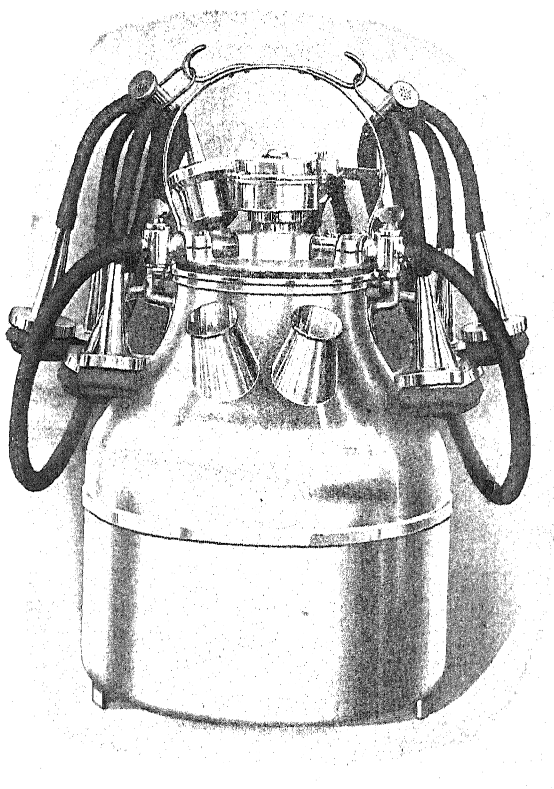

Plate I.—Burrell-Lawrence-Kennedy Milking Machine Used in Station Experiments.

GERM CONTENT OF THE MILK.

Bulletin 317[1] of this Station discussed the effect of methods of handling milking machines upon the germ content of the milk. The results of this study may be summarized as follows:

1. The immersion of the teat cups and the rubber parts of the machine in a 10 per ct. solution of salt (NaCl) between milkings is important. When daily washing and scalding of these parts was contrasted with washing them once per week and keeping them in a salt solution during the remainder of the time this latter treatment reduced the average germ content of the milk from over 180,000 germs per cc. to less than 20,000 per cc.

2. The air filters are also important in proportion as they remove the germ-laden dust from the air which enters the pail during the milking process. On the later types of machines used these filters were large enough to be quite efficient and the germ content of the milk, when the tubes had been held in brine and the filter cups had been properly filled with cotton, was almost always markedly below 10,000 per cc.

3. Dropping the teat cups on the floor during the milking process or any gross carelessness in handling the machine caused a surprising rise in the germ content of the milk. Occasionally very high counts were obtained where no definite cause could be found.

4. The point which is emphasized by these studies is that the quality of milk obtained from a milking machine depends primarily upon the intelligent care which is exercised in the manipulation of the machine.

While immersion in a solution of common salt supplemented by a careful hand washing of the teat cups and rubber tubes once per week was found to be both cheaper and more efficient than daily hand washing, the question of what is the best solution for protecting the rubber parts is still unsettled. This problem is being studied and the results will be reported later.

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[1] See footnote 1, p. 58.

TIME CONSUMED BY MACHINE MILKING.

An important economic question is the relative amounts of time consumed by hand and by machine milking. In practice the time required by either method varies greatly with the local conditions and those at this Station can not be considered as quite normal because there is here a distinct tendency to perform each operation more carefully and more slowly than under private conditions. This difference is especially marked in connection with milking, because the milk from each cow at each milking is weighed and recorded separately by the milker. From February to September, 1911, 144 sets of records were made by the barn foreman, Wm. Casey, of the time actually consumed by one man in using two milking machines, at the afternoon milkings.

Under the head, "Preparing the machine," these records show the time occupied in taking the teat cups and tubes from the brine, rinsing them, attaching them to the milking machines and filling the air filter in the dome with cotton. The time consumed by these operations ranged from three to seven minutes, averaging 3.36 minutes. It should be noted that this is the time for preparing two milking machines each provided with two sets of teat cups. The time required for one machine would be practically one-half of this or 1.68 minutes. With the earlier type of machine which required six to eight different sizes of teat cups the time would be longer. Likewise the filling of all of the air filters with cotton would have increased the time by about one-half minute. The time consumed in starting the electric motor and the vacuum pump, approximately one-half minute, should also be included in that of the preparations for milking, instead of in that of the milking process as in the present records.

Under the head, "Time of milking," these records include the time consumed in starting the electric motor and pump, taking the two machines into the stable, attaching them, milking each cow with the machine and stripping her by hand, weighing and recording the total yield of each cow separately and pouring the milk upon the cooler. With all of these items to attend to, two machines are as many as one man can satisfactorily manage.

The number of cows milked each day ranged from 12 to 18, with a mathematical average of 16.7 for each of the 144 days. The total time consumed in milking 2,400 cows was 7,197 minutes or an average of a cow in 2.94 minutes. Since four cows were being milked simultaneously this is really an allowance of 11.76 minutes per cow, including the time lost in emptying and transferring the machines.

The average yield per cow at the afternoon milking was 7.38 pounds.

Under the head, "Cleaning up at the barn," is included the rinsing out of the teat cups and machines, first with cold water, then with a hot solution of sal-soda or other cleaning compound, finally with hot water. This rinsing was accomplished by alternately plunging in and withdrawing the teat cups from a pail of the fluid so that air and fluid were alternately drawn through by the milking mechanism. After this rinsing the motor and vaccum pump were stopped and the teat cups and rubber tubes were replaced in the brine solution. The average time consumed by one man in thus cleaning two machines, including the time taken to prepare the sal-soda solution, was 7.68 minutes. The time required for rinsing one machine would have been more than one-half as long since one pail of fluid served for both machines in each instance.

In addition to the rinsing which the milking machines received at the barn after each milking the teat cups and rubber tubes were cleaned by hand once a week and the remaining parts of the milkers were carefully washed each day. According to the records kept by Thos. McGuiness, the average time consumed on 29 days by one man in washing the four sets of teat cups and rubber tubes was 18.3 minutes. The washing of the remaining parts of the two milkers on 174 days required an average of 8.13 minutes per day. This does not include the time of steaming the metal parts since they required no supervision after being placed in the steam box.

Combining these averages on the basis of a fifteen-cow dairy and assuming that these cows were milked by one man using two milking machines the computation would be as follows:

Preparing the machines night and morning..	6.72	minutes
Milking 30 cows (15 night and morning)....	88.20	minutes
Rinsing machines at barn night and morning.	15.36	minutes
Cleaning teat cups and tubes (1/7 of 18.3)..	2.61	minutes
Washing remaining parts of machines.......	8.13	minutes
Total time required for milking 30 cows.	121.02	minutes
Average time required to milk one cow......	4.034	minutes

These computations give an average of almost exactly four minutes per cow or a rate of fifteen cows per hour. Considering that in these experiments the yield of each cow was weighed and recorded separately and that one man did all of the work connected with the care of the milk and the milking machines, it would seem that under commercial conditions these figures would be easily equalled or excelled. It should also be noted that these figures are on the basis of fifteen cows which is probably as small a number as will be found profitable in connection with present machine milking. In this case approximately one-third of the total time was spent in other operations than in actually milking cows. As the number of cows increased, this extra consumption of time would become relatively less and the average time required per cow would decrease accordingly.

The average time taken by our hand milkers for milking, recording the weight and pouring the milk upon the cooler has been seven minutes per cow.

The question of the length of time required to milk cows by machines has been discussed by a number of experimenters. Lane[1] found that one man milking four cows with one machine averaged 3.32 minutes per cow for the actual milking time. One man milking ten cows with five machines completed the milking process in an average time of 1.85 minutes per cow.

[1] See footnote 2, p. 60.

Erf[1] calculated that the average time for the milking process with a machine was 2.3 minutes per cow.

Woll and Humphrey[2] found that where one man used two machines on twelve cows and did not have to record the weight of the milk he milked the cows with the machines and stripped them with an average of three minutes per cow.

These findings are at least roughly comparable with our observations where the actual milking of the cows and the care of the milk averaged 2.9 minutes per cow.

Haecker and Little[3] observed the time required by one man to milk, strip, and record the yield from twelve cows using one, two and three milking machines. In this case the time included that taken to rinse the machines both prior to and after the milking process (about 8 minutes). They found that with one milking machine the average time was 7.7 minutes; with two machines, 5.7 minutes; with three machines, 4.7 minutes.

The observations at this Station reduced to a comparable basis would be as follows:

Preparation of two machine milkers..........	3.36	minutes
Milking 12 cows at 2.94 minutes each.........	35.28	minutes
Cleaning up two milkers....................	7.68	minutes
Total time for 12 cows................	46.32	minutes
Average time for one cow..................	3.86	minutes

From this it will be seen that the time consumed in milking at the Nebraska Station was nearly double that taken by the present experiments.

A part of this difference may be ascribed to the fact that the Nebraska time tests were made in 1907–8 with an earlier type of machine using six different sizes of teat cups while those at this Station were made in 1911 with a later type using but a single size of teat cups. Obviously the time lost in changing from one

[1] See footnote 1, p. 60.
[2] See footnote 1, p. 62.
[3] See footnote 2, p. 61.

size cup to another would increase the total time consumed by the milking process.

In view of the unsatisfactory results which follow the failure to remove the milking machine when secretion has stopped, especially where the fit of the teat cup is not good, it seems possible that their somewhat unfavorable results with the milking machine may be closely connected with the fact that the milking machine was evidently left on the cows for unusually long periods.

COST OF MAINTENANCE.

Owing to the numerous changes in the milker on account of improvements which have been introduced there has been no opportunity to determine the expense of maintenance due to the wearing out of various mechanical parts of the machine.

IMPORTANCE OF TEAT CUPS.

In successful machine milking of cows the teat cup is of prime importance. Apparently the function of the teat cup is to support the exterior of the teat, allowing the vaccum to periodically release the sphincter muscle at its extremity and allow the milk to escape. Whenever the cup does not support the surface of the teat the return of blood through the veins is retarded, the extremity of the teat soon becomes enlarged and blue, the milk channel is closed and the milk cannot escape.

The teat cups furnished with the "Globe" machine were simply straight, stiff, rubber tubes with a soft collapsible upper edge and an outlet at the bottom to carry off the milk. These cups did not coincide with the outline of the teat and they were a failure. All teat cups furnished us with the Burrell-Lawrence-Kennedy machine have been conical.

With the earliest teat cups furnished with the present machine, eight different sizes were necessary in milking the Station herd. The form has undergone modification so that the same herd is now more efficiently milked with a single size of teat cup.

This improvement in the teat cups has reduced the labor of using the milking machine by doing away with the constant changing of the cups during the milking process; it has removed the danger of using the wrong cup on a cow by mistake as sometimes occurred with the former cups and it has practically obviated the misfits which were constantly occurring with cows whose teats were midway between the available sizes or due to the gradual decrease in size of the teat which occurs as lactation progresses.

This improvement in the teat cups is clearly shown in the relative amounts of strippings obtained with the various forms of teat cups.

During the two weeks following April 4, 1907, seventeen cows were milked with the machine equipped with the earlier form of teat cup. At the beginning of this period the machine had been in use four weeks, the cows had become fairly accustomed to it and the operator had decided the question of the proper size of teat cup.

The milk obtained by hand stripping from these seventeen cows during fourteen days amounted to 116.1 lbs. or a daily average of 0.49 lbs. per cow. In no case did the daily strippings fall below 0.2 lbs. from any cow and with ten of them they equalled or exceeded 1 lb. during one or more days. The maximum weight of daily strippings from a single cow was 2.8 lbs.

During the two weeks following May 10, 1912, ten cows were being milked with the same machines equipped with the newer type of teat cup with which but a single size is necessary in milking the entire herd. At this time the amount of strippings obtainable in most cases from a single cow was too small to weigh upon the available scales, the strippings from six of the cows being practically nothing. Accordingly the strippings obtainable from the entire ten cows were collected and weighed together. The maximum amount obtained in this way from the ten cows at any milking was 1 lb. and it reached this figure on only one day. The average daily strippings amounted to 0.11 lb. per cow or 0.055 lb. per

milking. This is approximately one-fifth of the amount obtained while using the earlier form of teat cup and is an amount closely approximating the natural secretion occurring between the close of the milking and the beginning of the stripping process.

EFFECT OF CHANGES IN VACUUM.

With this milking machine the milk is drawn by means of a vacuum, produced by an air pump and intermittently applied to the teat cups. The extent of this vacuum is measured by the inches it would depress a mercurial barometer and is indicated by an instrument similar to a steam gage. This vacuum, alternately formed and destroyed within the teat cup, simulates the sucking action of the calf's mouth. The violence of this sucking action and, within certain limits, the rate of milking depends upon the extent of the vacuum and the duration of the period through which it is applied. As already referred to under the discussion of teat cups, the vacuum, under unfavorable conditions, tends to change the blood flow and produce congestion of the teat. Not only does this congestion interfere with the escape of milk but when carried too far it may even result in escape of blood from the interior of the teat. This extreme result occurred with the straight sided teat cups of the Globe machine but has not been observed in connection with the present milking machine. In view of these serious consequences the question of vacuum has received much attention from the machine manufacturers and the influence of this factor has been observed during this study. "It is the conclusion of the manufacturers, after observing the effect of vacuum at several hundred installations during a period of five or six years, that the best results can be obtained by accurately maintaining the vacuum at 15 inches."[1]

During the spring of 1911 Prof. R. S. Breed, of Allegheny College, made an extensive study of the cellular content in the milk from the Station herd and in connection with this study

[1] Letter from Loomis Burrell, dated Nov. 14, 1912.

made observations upon the effect of variations in vacuum in machine milking. The results of his study will appear later as a bulletin of this Station but it will be of interest in this connection to note the effects produced upon the flow of milk and upon the teats of the cow by somewhat wide changes in vacuum continued for only a relatively short time.

Three cows which were in the later stages of their lactation periods were used in this study and all of the details of the machine milking were performed as usual except that the extent of the vacuum was varied. The varying amounts of vacuum employed and the amounts of milk obtained are given in Table I.

TABLE I.— CHANGES IN MILKING MACHINE VACUUM AND ITS EFFECT ON MILK FLOW.

Date.	Vacuum in inches.	Gertie F. No. 2. Per milking.	Gertie F. No. 2. Daily.	Ruth F. Per milking.	Ruth F. Daily	Millie D. Per milking.	Millie D. Daily.
1911.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Feb. 16.........	15	6.1	......	6.2	......	5.0	....
		5.8	11.9	4.6	10.8	5.0	10.0
" 17.........	......	6.2	......	7.8	......	4.8	....
		6.3	12.5	5.3	13.1	4.5	9.3
" 18.........	......	5.3	......	6.2	......	4.8	....
		6.4	11.7	5.5	11.7	4.5	9.3
" 19.........	......	7.0	......	7.0	......	5.0	....
		5.5	12.5	3.0	10.0	3.5	8.5
" 20.........	......	5.8	......	7.8	......	4.5	....
		5.8	11.6	5.7	13.5	4.8	9.3
" 21.........	......	5.8	......	6.4	......	4.7	....
		5.4	11.2	5.3	11.7	4.4	9.1
" 22.........	......	7.0	......	5.5	......	4.3	....
		5.8	12.8	5.3	10.8	4.4	8.7
" 23.........	15.5	5.7	......	5.4	......	5.0	....
		5.3	11.0	5.8	11.2	3.6	8.6
" 24.........	......	4.8	......	5.9	......	4.4	....
		7.6	12.4	5.4	11.3	3.8	8.2
" 25.........	......	4.0	......	5.7	......	4.4	....
		7.1	11.1	5.0	10.7	4.0	8.4
" 26.........	......	5.0	......	6.0	......	5.0	....
		5.9	10.9	5.0	11.0	3.8	8.8
" 27.........	......	6.2	......	5.4	......	4.7	....
		6.0	12.2	4.8	10.2	3.6	8.3
" 28.........	......	5.2	......	5.5	......	4.2	....
		6.3	11.5	5.1	10.6	3.8	8.0

TABLE I.— CHANGES IN MILKING MACHINE VACUUM AND ITS EFFECT ON MILK FLOW (*continued*).

Date.	Vacuum in inches.	Gertie F. No. 2.		Ruth F.		Millie D.	
		Per milking.	Daily.	Per milking.	Daily.	Per milking.	Daily.
1911.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
March 1.......	15.5	4.4	......	5.4	......	4.2	....
		7.0	11.4	5.5	10.9	3.9	8.1
" 2.......	......	4.8	......	5.8	......	4.0	....
		6.3	11.1	6.0	11.8	4.0	8.0
" 3.......	......	5.1	......	4.7	......	4.0	....
	16.5	5.8	10.9	4.9	9.6	3.5	7.5
" 4.......	......	5.1	......	5.7	......	4.3	....
		7.3	12.4	5.0	10.7	3.1	7.4
" 5.......	......	6.0	......	4.8	......	4.6	....
		5.7	11.7	4.8	9.6	3.2	7.8
" 6.......	......	5.4	......	5.4	......	3.9	....
		5.5	10.9	4.3	9.7	3.8	7.7
" 7.......	......	4.2	......	5.6	......	4.3	....
		7.1	11.3	3.7	9.3	3.4	7.7
" 8.......	......	5.6	......	5.1	......	3.6	....
		6.1	11.7	4.8	9.9	3.6	7.2
" 9.......	......	5.9	......	5.7	......	3.8	....
		5.1	11.0	3.9	9.6	3.5	7.3
" 10.......	......	5.3	......	5.5	......	4.2	....
" 10.......	17.5	6.4	11.7	3.4	8.9	3.3	7.5
" 11.......	......	5.4	......	5.6	......	4.5	....
		6.9	12.3	4.3	9.9	3.3	7.8
" 12.......	......	4.5	......	4.5	......	4.5	....
		6.8	11.3	4.0	8.5	3.6	8.1
" 13.......	......	6.1	......	5.0	......	4.0	....
		6.6	12.7	4.4	9.4	3.9	7.9
" 14.......	......	5.6	......	4.3	......	4.0	....
		6.5	12.1	4.5	8.8	3.3	7.3
" 15.......	......	5.2	......	4.2	......	4.4	....
		6.6	11.8	4.0	8.2	3.7	8.1
" 16.......	......	4.8	......	4.4	......	4.1	....
	18.5	7.1	11.9	4.1	8.5	3.6	7.7
" 17.......	......	6.2	......	4.7	......	4.0	....
		6.5	12.7	4.1	8.8	3.4	7.4
" 18.......	......	5.3	......	4.2	......	4.1	....
		6.6	11.9	4.1	8.3	3.5	7.6
" 19.......	......	4.3	......	4.8	......	4.2	....
		7.2	11.5	3.5	8.3	3.6	7.8
" 20.......	......	6.8	......	4.4	......	3.8	....
		6.7	13.5	4.4	8.8	3.3	7.1
" 21.......	......	5.3	......	4.2	......	4.3	....
		6.6	11.9	3.5	7.7	3.4	7.7
" 22.......	......	6.0	......	4.4	......	4.1	....
	19.5	7.0	13.0	3.5	7.9	3.6	7.7

TABLE I.—CHANGES IN MILKING MACHINE VACUUM AND ITS EFFECT ON MILK FLOW (*concluded*).

Date.	Vacuum in inches.	Gertie F. No. 2.		Ruth F.		Millie D.	
		Per milking.	Daily.	Per milking.	Daily.	Per milking.	Daily.
1911.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
March 23.......	18.5	4.6	......	4.4	......	4.0	....
	17.5	7.0	11.6	4.6	9.0	3.1	7.1
" 24.......	16.5	6.0	......	3.9	......	4.8	....
	15.5	6.8	12.8	3.5	7.4	3.0	7.8
" 25.......	15.0	4.0	......	3.2	......	4.1	....
		8.0	12.0	4.3	7.5	3.0	7.1
" 26.......	......	4.4	......	4.0	......	3.7	....
		6.7	11.1	5.5	9.5	3.3	7.0
" 27.......	......	6.7	......	3.7	......	4.0	....
		6.9	13.6	3.5	7.2	3.5	7.5
" 28.......	......	5.7	......	4.2	......	4.2	....
		6.5	12.2	3.2	7.4	3.5	7.7
" 29.......	......	6.5	......	3.5	......	4.0	....
		6.0	12.5	3.2	6.7	3.3	7.3
" 30.......	......	5.0	......	3.6	......	4.0	....
		7.2	12.2	3.4	7.0	3.3	7.3
" 31.......	......	6.0	......	3.6	......	3.7	....
		5.3	11.3	2.9	6.5	3.4	7.1

It will be seen from Table I that these marked changes in the vacuum produced no correspondingly marked changes in the flow of milk.

During the 44 days covered by this experiment there was a marked decrease in flow in the case of Ruth, a smaller decrease with Millie D. and practically none at all with Gertie. There is a close connection between this decrease in flow and the period of lactation of the cows. Ruth F. who gave 4.12 lbs. of milk per day less during the last week of the experiment than during the first was then within 29 days of the close of her lactation period. Millie D. who during the same time had decreased her daily flow only 1.99 lbs. continued in milk 42 days after the close of this experiment, while Gertie F. No. 2, whose milk flow did not decrease during the experiment, gave milk for 92 additional days.

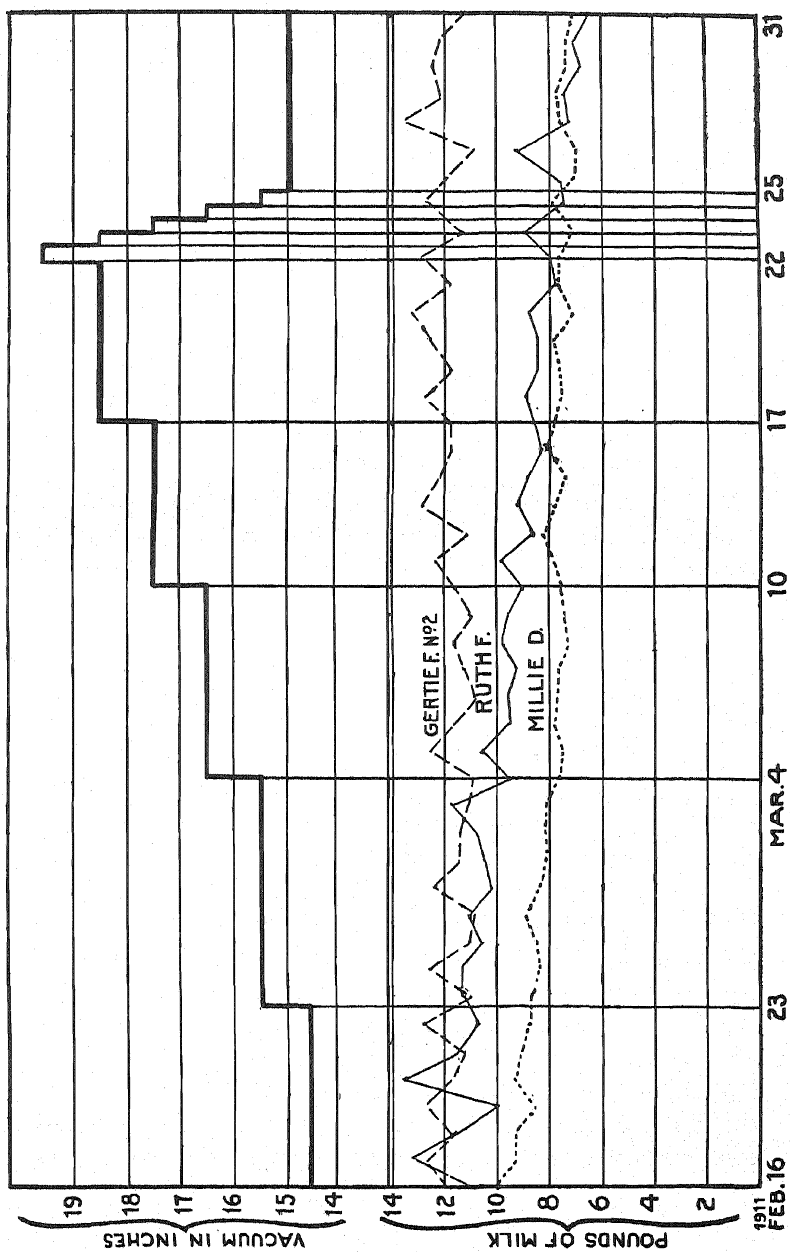
Not only is there no effect of the change of vacuum shown in the general trend of the milk flow but also there is no evidence of any checking effect even at the time when the changes in vacuum occurred. A comparison of the yield at the fifteen milkings at which the vacuum was raised with that at the last corresponding milkings before the change shows that there was a slight increase in milk flow accompanying the increase in vacuum in the case of Gertie F. No. 2 and Millie D. and a somewhat larger decrease in the case of Ruth. This resulted in an average decrease of 0.1 lb., due to the fact that Ruth was decreasing very rapidly in her milk flow. This slight change in the immediate milk flow in connection with the marked change in vacuum is especially noteworthy since cows respond immediately to any detectable change in their milking conditions and this response almost always takes the form of a decreased milk flow.

The relation of the vacuum to the milk flow as given in Table I is shown graphically in Graph I, opposite.

Not only was there no demonstrable effect of the change of vacuum upon the flow of milk but also there were no objectionable local effects upon the cows. It is true that at the close of the milking process with the higher vacuum there was some difference of opinion as to the presence of a slight congestion at the extremity of the teats on Ruth F. Whatever abnormality may have been present passed away within a few minutes leaving no objectionable after effect.

In considering the bearing of this experiment upon the relation of vacuum to the flow of milk it should be remembered that the test was made upon only three cows. These were late in their period of lactation when they may have been less susceptible to unfavorable influences and they were provided with good fitting teat cups which would reduce any unfavorable influences of the high vacuum. Under such conditions it seems fairly clear that the higher vacuum exerted no measurable influence upon the flow.

On the other hand it should be remembered that under ordinary dairy conditions it is difficult to insure a perfect fit of the teat cup in all cases and any error in manipulation will be exaggerated



GRAPH I.—RELATION OF VACUUM TO MILK FLOW.
(See Table I.)

in the presence of a higher vacuum. As there is no evidence that the higher vacuum contributes anything to the success of the machine milking and as its use is attended with grave dangers it is the part of wisdom to operate the milking machine with as slight a vacuum as is feasible.

IMPORTANCE OF THE OPERATOR.

In this and other publications on milking machines emphasis is laid upon the intelligence of the man in immediate charge of the machine as a large factor in its success. Unless he is above the average of farm laborers in mechanical skill and general trustworthiness the best results are not to be expected. On the other hand it would be erroneous to assume that it is only the exceptional man who can operate milking machines successfully. During the five years covered by this test our barn men have changed frequently so that the actual running of one or both of the two machines has been intrusted to six different men. Two of these men ran a machine for three and four months respectively, two for one year each, one for one and one-half and one for three years. None of these men had had any previous experience with milking machines except what two of them had acquired from the Globe milker, and the prejudice which they received from the failure of this machine fully offset any gain they may have obtained from that experience. Taken as a whole they represented very well the better class of farm workmen and they had been selected for reasons entirely aside from their ability to operate machinery. While the degree of their success with the machines varied slightly none of them would be classed as failures and the results given in this publication are those obtained by them without any omissions or corrections.

While these facts make it evident that the successful operation of milking machines is not restricted to persons of unusual ability they should not be understood as showing that the personality of the men is unimportant since all of these were in a sense picked men and they were at all times under the supervision of one of us

(S) who was actually present at a very considerable proportion of the milking periods.

EFFECT OF MACHINE MILKING ON FLOW.

In 1907 the Station herd was milked by machine. A comparison of the milk flow during that season with the corresponding yields for the preceding period of lactation is open to criticism since the weather conditions each season markedly influenced the quality of the available food supply. Accordingly as the cows began their lactation period in 1908 they were divided into two groups, one of which was milked by machines and the other by hand. In forming these groups care was exercised to divide the herd as evenly as possible with regard both to the age of the cows and their general productivity.

At each succeeding period of lactation the manner of milking was changed so that each cow was milked by machine and by hand during alternate periods, and during any given season approximately the same number of cows were being milked by each method.

The progress of this test was necessarily disturbed by the mishaps incident to handling a dairy herd. The disturbances in milk flow due to abortion make it desirable to omit a period of lactation from the comparisons in the case of six cows. Sterility, accidents and the weeding-out process which is constantly going on in all good herds also led to the sale of a number of animals. These changes not only resulted in a reduction in the amount of comparable data but they tended also to destroy the balance between the two groups of animals during any given year. In order to correct these evils as fully as possible the removals from each class were replaced by heifers as fast as they became available.

The records obtained by comparing 29 cows during two or more periods of lactation are given in Table II. In the column of yields in this table, H and M indicate respectively, hand and machine milking.

TABLE II.—VARIATION IN YIELD OF COWS MILKED BY HAND OR MACHINE IN ALTERNATING LACTATION PERIODS.

Number.	Name and breed.	Age.	Year.	Dry.	In milk.	Milk.		Direction of variation.		
						Per ct. fat.	Yield.	Hand.	Machine	
		Years.		Days.	Days.	Per ct.	Lbs.			
No. 1....	Millie D., Jersey....	4	1906–7	38	365	6.07	H. 5,821	....	....	
		5	1907–8	48	340	6.23	M. 6,456	....	+	
		6	1908–9	41	324	6.26	M. 7,455	....	....	
		7	1909–10	31	347	5.63	H. 7,595	+	....	
		8	1910–11	34	334	5.69	M. 5,666	+	....	Yield about same '12.
No. 2....	Millie G., Jersey....	3	1906–7	30	350	6.04	H. 5,247	....	....	
		4	1907–8	20	215	5.94	M. 4,765	+	....	
		5	1908–9	91	352	5.83	H. 6,085	+	....	Udder accident, '09.
No. 3....	D. H. Carey, Jersey..	6	1906–7	46	356	5.34	H. 7,009	....	....	
		7	1907–8	20	360	5.35	M. 6,918	+	....	
		8	1908–9	30	365	5.3	H. 5,970	....	+	Did not go dry.
		9	1909–10	00	286	5.43	M. 4,657	+	....	Had indigestion.
		10	1910–11	91	365	5.18	H. 8,001	+	....	Profited by long rest.
No. 4....	Carey of S., Jersey...	3	1906–7	22	337	6.53	H. 4,870	....	....	
		4	1907–8	34	315	6.31	M. 4,208	+	....	
		5	1908–9	96	357	6.45	H. 6,310	+	....	Profited by long rest.
		6	1909–10	00	290	6.55	M. 3,502	+	....	Did not go dry.
		7	1910–11	71	365	6.11	H. 7,194	+	....	Profited by long rest.
No. 5....	Mabel G., Jersey....	3	1906–7	27	340	5.41	H. 3,836	....	....	
		4	1907–8	40	325	5.40	M. 3,431	+	....	Sold for beef.
No. 6....	Princess A., Jersey...	4	1906–7	42	332	5.46	H. 4,187	....	....	Teats very small.
		5	1907–8	33	354	5.51	M. 5,305	....	+	
		6	1908–9	46	360	5.7	M. 5,132	....	....	

No. 7.....	Belle of the Station, Jersey.	4	1906–7	26	365	5.79	H. 8,541	....	....	
		5	1907–8	19	350	5.88	M. 7,583	+	....	Sold '09. Sterile.
No. 8.....	Hammond No. 2.... Grade Jersey.	8	1906–7	15	365	5.66	H. 7,649	....	....	
		9	1907–8	00	365	5.72	M. 7,434	+	....	
		10	1908–9	00	365	5.67	H. 7,366	....	+	
		11	1909–10	31	334	5.54	M. 6,746	+	....	
		12	1910–11	36	365	5.47	H. 9,446	+	....	Sold '11. Sterile.
No. 9.....	Satie.............. Grade Jersey.	8	1906–7	26	365	4	H. 11,596	....	....	
		9	1907–8	10	365	3.94	M. 9,795	+	....	
		10	1908–9	00	351	4.02	H. 9,059	....	+	Sold '10. Garget.
No. 10.....	Gertie .... Grade Jersey.	5	1906–7	25	352	5.19	H. 6,557	....	....	Sold '09.
		6	1907–8	28	365	5.3	M. 10,751	....	+	Udder accident.
No. 11.....	Ruth S............ Grade Jersey.	3	1906–7	10	349	5.07	H. 6,643	....	....	
		4	1907–8	16	335	4.94	M. 7,170	....	+	
		5	1908–9	30	319	5.6	H. 6,027	....	+	Sold '11.
		6	1909–10	46	340	5.4	M. 6,988	....	+	Udder accident.
No. 12.....	Dolly.............. Grade Jersey.	9	1906–7	41	365	5.74	H. 7,844	....	....	
		10	1907–8	11	354	5.83	M. 8,881	....	+	
		11	1908–9	39	344	6	H. 7,792	....	+	Sold '09. Sterile.
No. 13.....	Nora .... Grade Jersey.	3	1906–7	43	344	5.46	H. 5,429	....	....	
		4	1907–8	83	311	5.5	M. 5,588	....	+	
		5	1908–9	54	257	5.4	M. 7,136	....	....	
		6	1909–10	108	333	5.3	H. 8,492	+	....	
		7	1910–11	32	305	5.6	M. 6,961	+	....	
No. 14.....	Fannie............ Grade Jersey.	3	1906–7	38	350	4.98	H. 6,601	....	....	
		4	1907–8	43	308	4.96	M. 5,704	+	....	Sold '09. Garget.
No. 15.....	Nancy............ Grade Holstein.	6	1906–7	28	335	3.96	H. 7,106	....	....	
		....	1907–8	34	365	3.96	M. 7,067	+	....	
		....	1908–9	49	316	4	M. 6,977	....	....	Sold '09. Sterile.

TABLE II. — VARIATION IN YIELD OF COWS MILKED BY HAND OR MACHINE IN ALTERNATING LACTATION PERIODS (*concluded*).

Number.	Name and breed.	Age.	Year.	Dry.	In milk.	Milk.		Direction of variation.		
						Per ct. fat.	Yield.	Hand.	Machine.	
		Years.		*Days.*	*Days.*	*Per ct.*	*Lbs.*			
No. 16.....	Anna G............	4	1908–9	20	356	5.91	H. 6,920	....	....	
	Grade Jersey.	5	1909–10	32	332	5.51	M. 6,808	+	....	
No. 17.....	Ruth F............	2	1908–9	....	365	5.73	M. 6,118	....	....	Aborted as heifer.
	Grade Jersey.	3	1909–10	50	349	5.19	H. 7,217	+	....	
		4	1910–11	45	336	4.87	M. 6,683	+	....	
No. 18.....	Gertie F. No. 1....	2	1907–8	00	365	6.23	M. 5,521	....	....	Did not go dry.
	Grade Jersey.	3	1908–9	00	303	6.05	H. 3,504	....	+	Calf premature.
		4	1909–10	52	365	5.82	M. 7,382	....	+	
		5	1910–11	34	331	6.55	H. 4,302	....	+	
No. 19.....	Millie F., Jersey.....	2	1907–8	00	365	5.3	M. 6,536	....	....	
		3	1908–9	00	305	5.5	H. 4,646	....	+	Calf premature.
		4	1909–10	65	338	5.76	M. 8,156	....	+	
		5	1910–11	50	350	5.19	H. 8,175	+	....	
No. 20.....	Mabel G. 2, Jersey..	2	1908–9	....	365	5.84	H. 5,533	....	....	
		3	1909–10	30	338	5.84	M. 5,798	....	+	Sold.
No. 21.....	Millie F. B. B., Jersey	2	1908–9	....	356	6.1	M. 5,733	....	....	
		3	1909–10	9	298	6.21	H. 5,344	....	+	
		4	1910–11	67	305	6.07	M. 5,347	....	+	
No. 22.....	Carey S. F., Jersey...	2	1909–10	....	365	6.42	H. 6,369	....	....	
		3	1910–11	72	337	6.76	M. 6,589	....	+	

No. 23.....	Hammond F. No. 1.	2	1908–9	....	355	5.51	M. 6,391	....	....	
	Grade Jersey.	3	1909–10	20	335	5.71	H. 6,895	+	....	
		4	1910–11	69	324	5.25	M. 5,587	+	....	Had indigestion.
No. 24.....	Chloe B...........	2	1909–10	....	351	6.05	H. 5,121	....	....	
	Grade Jersey.	3	1910–11	58	335	5.79	M. 6,778	....	+	
No. 25.....	Gertie F. No. 2....	2	1908–9	....	365	4.77	M. 5,429	....	....	Aborted as heifer.
	Grade Jersey.	3	1909–10	51	343	4.9	H. 7,518	+	....	
		4	1910–11	58	330	4.71	M. 5,570	+	....	Had indigestion.
No. 26.....	Hammond F. 2......	2	1909–10	....	352	5.29	M. 7,174	....	....	
	Grade Jersey.	3	1910–11	69	331	5.49	H. 8,021	+	....	
No. 27.....	Gertie F. 3..........	2	1909–10	....	365	5.48	M. 5,106	....	....	Aborted as heifer.
	Grade Jersey.	3	1910–11	48	365	5.26	H. 8,027	+	....	
No. 28.....	Carey S. B. B., Jersey.	2	1910–11	....	332	6.58	M. 5,464	....	....	Calf premature.
		3	1911–12	36	312	6.36	H. 6,206	+	....	
No. 29.....	Dolly F. B. B........	2	1910–11	....	360	6.05	M. 6,318	....	....	
	Grade Jersey.	3	1911–12	48	295	6.40	H. 4,785	....	+	Partly machine milked.

The records of the 29 cows as given in the above table include five lactation periods of five cows, four periods of three cows, three periods of nine cows and two periods of twelve cows, or a total of 88 complete lactation periods. During 43 of these periods the cow was milked by hand and during 45 periods by machine.

By comparing the yields obtained when any cow was milked by the two methods during successive periods it is possible to obtain 55 comparisons of which 32 were in favor of the hand method and 23 were favorable to the machine method of milking. On the face of these results it appears that while the amount of milk obtained by the two methods is about the same the chances are about two out of three that a little more milk will be obtained by hand milking.

From the column of remarks at the right of the table it will be seen that many of the cows were somewhat abnormal at some time during the test.

Five of the cows lost portions of their udders either through accident or from garget. In such cases the yields for the periods of lactation in which such mishaps occurred are not included in the table and the cows were removed from the experiment.

Four of the cows were sold on account of sterility. During their last milking periods two were milked by hand and two by machine. These items would seem to be well balanced were it not for the fact that No. 8 in her closing period had an unusual flow. Her gain of 2,700 lbs. was probably not due to the fact that she was hand milked, as she had yielded fairly uniformly during the four preceding years. It may be ascribed to great bodily vigor unhampered by the demands of gestation.

During 1908 four of the young cows calved prematurely as well as one each in 1909 and 1910. Under such conditions their yields can not be considered as normal and their failure to produce as much as during other lactation periods can not justly be ascribed to the method of milking. Accordingly the results from these six periods of lactation should be omitted from the comparisons. This would destroy eight of the above comparisons, four of which were favorable to each method.

Three cows suffered severely from indigestion and their yields dropped 1,200 to 1,900 lbs. below their preceding yields. A fair treatment of the data demands that the yields during these years be dropped. This will eliminate four comparisons all of which were favorable to hand milking.

Discarding the questionable results as indicated above leaves 43 comparisons of the yields of which 24 are favorable to hand and 19 to the machine method of milking.

An inspection of the yields shows that the length of time during which a cow was dry exerted a marked influence upon the next period of lactation. In seven cases there was no interval between lactation periods. Three of these have been dropped from the comparison on account of abortion or indigestion. There remains a total of 15 instances where the interval between lactation periods was less than 21 days. Such short intervals are not ideal and might be considered as abnormal if they did not constitute approximately 20 per ct. of the total. Since the number of instances is considerable and is quite evenly divided between the two methods of milking it seems allowable to use the data in this comparison. Discarding this portion of the data would change the final balance by 7,806 lbs. in favor of the hand method.

In considering the relative merits of these two methods attention should be drawn to cows Nos. 6 and 29. The former had such small teats that hand milking was a slow and unsatisfactory process while the latter had large teats but was so hard to milk that she was drying up rapidly when the machine was substituted for the hand method. Neither of these cows would have been a desirable member of a hand-milked herd while both were satisfactory when milked by machine.

The above comparison of the yields of cows suggests that they have a tendency to give a larger flow when milked by hand than when milked by machine. A measurement of this tendency can be obtained in pounds of milk by striking a balance at the close of each year of the experiment. The balance for each of the four years as well as the balance for the entire experiment is given in Table III.

TABLE III.—ANNUAL AND TOTAL VARIATION APPARENTLY DUE TO METHOD OF MILKING.
(Includes all satisfactory data.)

Number.	Hand, 1906.	Machine, 1907.	Machine, 1907.	Hand, 1908.	Machine, 1908.	Hand, 1909.	Hand, 1908.	Machine, 1909.	Machine, 1909.	Hand, 1910.	Hand, 1909.	Machine, 1910.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	5,821	6,456	......	......	7,455	7,595	......	......	......	......	7,595	5,666
2	5,247	4,765	4,765	6,085	......	......	......	......	......	......	......	......
3	7,009	6,918	6,918	5,970	......	......	......	......	......	......	......	......
4	4,870	4,208	4,208	6,310	......	......	6,310	3,502	3,502	7,194	......	......
5	3,836	3,431	......	......	......	......	......	......	......	......	......	......
6	4,187	5,305	......	......	......	......	......	......	......	......	......	......
7	8,541	7,583	......	......	......	......	......	......	......	......	......	......
8	7,649	7,434	7,434	7,366	......	......	7,366	6,746	6,746	9,446	......	......
9	11,596	9,795	9,795	9,059	......	......	......	......	......	......	......	......
10	6,557	10,751	......	......	......	......	......	......	......	......	......	......
11	6,643	7,170	7,170	6,027	......	......	6,027	6,928	......	......	......	......
12	7,844	8,881	8,881	7,792	......	......	......	......	......	......	......	......
13	5,429	5,588	......	......	7,136	8,492	......	......	......	......	8,492	6,961
14	6,601	5,704	......	......	......	......	......	......	......	......	......	......
15	7,106	7,067	......	......	......	......	......	......	......	......	......	......
16	......	......	......	......	......	......	6,920	6,808	......	......	......	......
17	......	......	......	......	......	......	......	......	......	......	7,217	6,683
18	......	......	......	......	......	......	......	......	7,382	4,302	......	......
19	......	......	......	......	......	......	......	......	8,156	8,175	......	......
20	......	......	......	......	......	......	5,533	5,798	......	......	......	......
21	......	......	......	......	5,733	5,344	......	......	......	......	5,344	5,347
22	......	......	......	......	......	......	......	......	......	......	6,369	6,589
23	......	......	......	......	6,391	6,895	......	......	......	......	......	......
24	......	......	......	......	......	......	......	......	......	......	5,121	6,778
26	......	......	......	......	......	......	......	......	7,174	8,021	......	......
29	......	......	......	......	......	......	......	......	......	......	4,785	6,318
Totals	98,936	101,056	49,171	48,609	26,715	28,326	32,156	29,782	32,960	37,138	44,923	44,342
Group balance	......	2,120	562	......	......	1,611	2,374	......	......	4,178	581	......
Annual balance	......	2,120	562	......	......	......	3,985	......	......	......	4,759	......

Final balance (in favor of hand milking), 6,062 lbs.= 1 per ct. of total (574,114).

During their lactation periods beginning in 1906 the cows were milked by hand and during 1907 by machine. A comparison of the results for these two years is open to the criticism that they may have been influenced by seasonal variation. Beginning with their periods in 1908 one-half of the cows were milked by each method to meet this objection. However, comparison in yields could not be made in 1908 for the cows milked by machine, since these cows had also been milked by machine in 1907; so these yields do not appear in this table until the following year. Beginning with the comparison for 1908-1909 the data is so arranged as fairly to neutralize the influence of seasonal variation upon the yield.

Considering the results shown under the head of group balances and noting the variations of yield of the members of the given group it will be seen that in four of the six groups there is at least one cow whose variation in yield in successive years is greater than the group balance. Under such circumstances the elimination of this variable cow from any of the above groups would have caused the group balance to favor the opposite method of milking.

It will be seen from the record of Cows Nos. 1 and 13 as given in Table II that these large variations in yield are not necessarily connected with the manner of milking. During the successive seasons when these cows were milked by machine they varied 1,000 and 1,500 lbs. respectively.

Moreover these seasonal variations in the yields are in perfect accord with ordinary experience among hand-milked cows. The data on earlier yields during succeeding lactation periods in the Station herd were burned with our barn in 1904 and similar data on the basis of lactation periods have not been found in Station literature. However data for the yields during two successive calendar years are available for 13 cows in the Annual Reports of the Maine Station[1] for 1897 and 1898. The total yield of

[1] Gowell, G. M. Herd records. Me. Agr. Exp. Station An. Reps. 13 (1897): 192–200. 1898; and 14 (1898): 148–157. 1899.

the 13 cows during these two years was 155,308 lbs., that for 1898 being the smaller by 8,712 lbs. or 5.6 per ct. Likewise in Bulletin 102 of the Wisconsin Station[1] there is given the annual yield of 27 cows during two years. The total yield was 398,690 lbs. with a difference of 4,128 lbs. or 1 per ct. in favor of the second year. Combining the data from these two groups in such a way as to reduce the variation as far as possible the yield of these 40 cows during two succeeding years varied by 4,584 lbs. which was .82 per ct. of the total yield during a time equivalent to 80 lactation periods.

From this data it would appear plain that the increase of 1 per ct. in yield during the hand milking of the cows as given in Table III is clearly within the variation which may reasonably be expected from the annual fluctuations in the yield of cows.

The fact that the final balance in favor of the hand method in Table III is merely an accidental result of the method of grouping the data is well illustrated by arranging the data on a slightly different but equally logical basis. If the comparison of the otherwise satisfactory data be restricted to those cases where there are data for an even number of successive years for one cow milked alternately by the two methods, the data from nine lactation periods will be rejected. The data thus selected are given in Table IV.

This arrangement of the data shows that in the 62 lactation periods, 31 of which were with hand milking and 31 with machine milking, 3,285 pounds more milk were obtained by the machine than by hand. Here again the difference is unimportant being only 0.8 per ct. of the total milk obtained. Had the yields of cow No. 10 for 1906 and 1907 been omitted the balance would have been 909 pounds in favor of hand milking. Here also the accumulated variation between two groups of 31 members each is less than the variation between individual members of the group.

[1] Carlyle, W. L., and Woll, F. W. Studies in milk production. Wis. Agr. Exp. Station Bul. 102. 1903.

TABLE IV.— YIELDS OF COWS MILKED BY HAND AND MACHINE.
(Including only balanced periods for each cow.)

Number.	Hand, 1906.	Machine, 1907.	Hand, 1908.	Machine, 1908.	Hand, 1909.	Machine, 1909.	Hand, 1910.	Machine, 1910.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	5,821	6,456	....	7,455	7,595	....	....	....
2	5,247	4,765	....	....	....	....	....	....
3	7,009	6,918	....	....	....	....	....	....
4	4,870	4,208	6,310	....	....	3,502	....	....
5	3,836	3,431	....	....	....	....	....	....
6	4,187	5,305	....	....	....	....	....	....
7	8,541	7,583	....	....	....	....	....	....
8	7,649	7,434	7,366	....	....	6,746	....	....
9	11,596	9,795	....	....	....	....	....	....
10	6,557	10,751	....	....	....	....	....	....
11	6,643	7,170	6,027	....	....	6,988	....	....
12	7,844	8,881	....	....	....	....	....	....
13	5,429	5,588	....	7,136	8,492	....	....	....
14	6,601	5,704	....	....	....	....	....	....
15	7,106	7,067	....	....	....	....	....	....
16	....	....	6,920	....	....	6,808	....	....
17	....	....	....	....	7,217	....	....	6,683
18	....	....	....	....	....	7,382	4,302	....
19	....	....	....	....	....	8,156	8,175	....
20	....	....	5,533	....	....	5,798	....	....
21	....	....	....	5,733	5,344	....	....	....
22	....	....	....	....	6,369	....	....	6,589
23	....	....	....	6,391	6,895	....	....	....
24	....	....	....	....	5,121	....	....	6,778
26	....	....	....	....	....	7,174	8,021	....
29	....	....	....	....	....	6,318	4,785	....
Totals	98,936	101,056	32,156	26,715	47,033	58,872	25,283	20,050

Total machine	206,693
Total hand	203,408
Balance (in favor of machine)	3,285 = 0.8 per ct. of total (410,101).

In handling data which is subject to considerable variation reliable measurements may often be obtained by accumulating such a mass of data as to equalize the disturbing factors. However in the present instance the natural variation in the yield of the cow is so very large and the influence of the manner of milking, when properly done, is so very small that the actual measurement of the influence of the machine method of milking upon the flow of milk under present conditions is practically impossible.

In connection with this statement it should be distinctly understood that just as hand milking varies from a manipulation which promptly stops the flow to that which encourages the flow to the full capacity of the cow so machine milking may be of every degree of desirability depending upon the mechanical principles of the machine and the skill with which it is operated.

The problems in this connection which now await solution are the relative merits of the various mechanical principles and the conditions under which they can be applied most advantageously.

CONCLUSIONS.

One of the limiting factors in the development of the dairy business is the difficulty in obtaining regular and efficient milkers. The interest in the milking machine is largely due to the possibility of displacing a considerable amount of low-grade labor by a single higher grade, better paid man.

This study of the influence of hand and machine methods upon the flow of milk covers a period of over four years. During this time approximately 11 cows were milked by machine and an equal number by hand during their lactation period. All machine milked cows were stripped by hand and the milk so obtained was credited to their flow. As the result of mishaps incident to dairying satisfactory data was obtained from only 71 lactations.

Owing to the interest on the investment in machinery and to the time which is necessarily lost in preparing and later clean-

ing the milking machines it is probably not profitable to use machines in dairies of less than 15 cows. In such a dairy one man using two machines will milk cows within an average time of 3 minutes but the time lost in preparing and cleaning the machine will equal 1 minute per cow. With a larger dairy this latter item will be much reduced.

The normal variation in flow in a large group of cows is at least 1 per ct. The effect of the manner of milking, provided that it is thoroughly done, is less than this amount and therefore is not measurable.

During the earlier years difficulty was experienced in milking some of the cows. This difficulty arose from the failure of the teat cups to fit properly. When this was overcome the cows milked well. One small-teated and one very hard-milking cow, neither of which was suitable for hand milking, did well with the machine.

The success of the milking machine, like any other machine, is closely associated with the personality of the operator. During this experiment the machines have been operated by six different men, all of whom have done at least fairly well.

In this study the attempt has been made to contrast the machine and hand methods of milking at their best. Unquestionably it takes a higher grade man to operate a milking machine successfully than to hand-milk a cow equally well. There is every reason to think that in the hands of careless operators the machines will work injury to the cows but the same result is too often obtained from inefficient hand milking.

The milking machine is becoming a recognized part of the equipment of large dairies. It has already reached the point where it compares favorably with ordinary hand milking in the items of germ content of the milk and in its effect upon the flow. There is still room for much improvement from the mechanical standpoint, especially in the matter of simplicity and expense of installation.

A STUDY OF THE METABOLISM AND PHYSIOLOGICAL EFFECTS OF CERTAIN PHOSPHORUS COMPOUNDS WITH MILCH COWS, II. *

A. R. ROSE.

SUMMARY.

The chief aim of this experiment was to check the results reported in Technical Bulletin No. 1, of this Station, by repeating the work in such a way as to eliminate more of the variable factors. This was effected by adjusting one of the animals used in the previous experiments to a low-phosphorus ration very nearly identical with the one formerly employed and adding thereto the calcium salt of phytin.

In this, as in the former experiments, the organic phosphorus ingested was eliminated very largely in the form of inorganic phosphorus by way of the intestine, the amounts of phosphorus in the urine being very small. When phytin was withdrawn from the ration, the decrease of phosphorus in the urine was immediate; when phytin was added, a rise in phosphorus occurred after a lag of two days. Phytin caused more phosphorus to be eliminated through the kidney than did whole wheat bran. The long duration of the low-phosphorus period did not in itself affect the phosphorus content of the urine nor the phosphorus balance.

The insoluble phosphorus of the feces diminished with decreasing amounts of insoluble phosphorus in the rations, when the latter ranged above fourteen grams.

The soluble organic phosphorus disappeared very largely from the alimentary tract. The apparent utilization was poorer in the low-phosphorus periods and in the calcium phytate period than in the whole-bran period.

For maintenance of phosphorus equilibrium in this species of animal the requirement would seem to be the amount of phosphorus eliminated in the milk plus twenty-six milligrams per kilo of body weight; an excess over this amount causes phosphorus retention, and smaller quantities result in loss of phosphorus from the organism.

The addition of calcium phytate increased the potassium both in the urine and dung, and changed the path of elimination of part of the magnesium from the kidney to the intestine. The calcium added as calcium phytate was almost entirely eliminated by the intestine immediately after administration. The calcium of the urine increased with decreasing phosphorus in the rations and decreased when calcium phytate was added.

* A reprint of Technical Bulletin No. 20, May, 1912.

The nitrogen compounds of the ration were well utilized and for the most part a positive nitrogen balance was maintained. The animal gained 19 kilos during the experiment, half of which could be accounted for by the plus balance of nitrogen. There was a suggestion of a parallelism between the nitrogen and phosphorus balances.

The former observations as to the influence of phosphorus compounds on the oestrum and the amount of urine voided were not corroborated; neither was the laxative effect previously noted. The difference in the moisture content of the feces of the several periods of this experiment was very small.

A long low-phosphorus period resulted in unfavorable symptoms. The animal returned to a normal condition after a week's feeding on ash-rich rations including alfalfa, silage and wheat bran.

The volume of the milk fluctuated inversely with the amount of phytin phosphorus in the rations. The increase of milk flow on removal of phytin was not a mere dilution. Except for the change in the amount of fat, the composition of the milk was not materially altered. The responses of the fat to the fluctuations of phytin phosphorus were immediate and consistent, as distinct, though not quite as large, as in the previous experiments. The best milk flow, both as to amount and fat content, happened to occur in the period of phosphorus equilibrium.

INTRODUCTION.

The work reported in this bulletin is the fourth experiment in a series planned by Director Jordan in 1904, for the purpose of ascertaining the specific influence of the ash constituents of plants upon animal metabolism and especially to learn what effect these very important elements may have on milk production. As biochemical research progresses, we have come to realize more and more the very important part which the ash constituents play in all process of life. Agricultural chemists have given much attention to phosphorus, and this important substance has become familiar to farmers. It was naturally, therefore, the first element to be studied in this undertaking, and this substance still holds the chief interest of those carrying out Director Jordan's comprehensive program.

The first task of the investigators was to find out the nature of phosphorus in the grains and forage plants usually employed in feeding cattle. This work was published as bulletins 238 and 250 of this Station by Hart and Andrews, and Patten and Hart, respectively.[1] In these bulletins it is shown that the phosphorus of the grains is very largely in the form of a soluble organic compound,

[1] Hart and Andrews, N. Y. Agr. Expt. Sta. Bull. No. 238.
Patten and Hart, N. Y. Agr. Expt. Sta. Bull. No. 250.

previously described and named by the Swiss chemist, Posternak.[1] Phytin, as this compound is called, is in itself a very interesting substance; but its physical and chemical properties will not be discussed in this report. For descriptions of phytin, the reader is referred to the bulletins mentioned above and the paper by Posternak. The author wishes, however, to make a correction with respect to the constitution of phytin as given in these bulletins. The more recent work[2] has demonstrated that its acid is not anhydrooxymethylenediphosphoric acid as stated by Posternak and accepted by Hart at the time of publication of his work, but is an inositephosphoric acid. Recent work by Anderson[3] carried on in the laboratory of this Station confirms this later view of the chemical constitution of phytin.

PREVIOUS EXPERIMENTS.

The role of phosphorus in metabolism has been a live question for a long time and a large mass of data has been accumulated regarding it. A number of important facts are definitely established and others have been suggested. Since these have been summarized by Jordan, Hart, and Patten[4] and more recently reviewed in detail by Albau and Neuberg,[5] the reader is referred to these and only those references will be made which bear on special points as the discussion progresses. Technical Bulletin No. 1 of this Station reports the first three feeding experiments in this series and is a valuable contribution to our knowledge of mineral metabolism. The chief component of the rations used was wheat bran, chosen because of its relatively high content of phytin, which can be easily removed by leaching, the other constituents contributing but a very small amount of phosphorus. By alternating periods of rations containing washed and unwashed bran, a marked contrast in the amount of administered phosphorus was produced. This ranged from thirteen to sixteen grams in the low phosphorus period and from seventy-seven to eighty-one grams in the high phosphorus period. Excepting the variations in calcium, magnesium, and potassium, the other conditions were kept as constant as is practicable in experiments of this kind. A large number of observations were made and from the mass of analytical data the authors drew conclusions which may be briefly summed up as follows:

Increase of phosphorus in the ration increases the phosphorus elimination;

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[1] Posternak; *Rev. Gen. Bot.* **12:** 5, 65 (1900); *Compt. Rend. Soc. Biol.* **55:** 1190 (1902); *Compt. Rend.* **137:** 202, 337, 439 (1903); **140:** 322 (1905).

[2] Suzuki, Yoshimura, Takaishi. Bul. Coll. Agr. Tokio, **7:** 495, 503, 1907.
Neuberg; *Biochem. Ztschr.* **9:** 557 (1908); Starkenstein; *Biochem. Ztschr.* **30:** 56 (1910).

[3] Anderson, R. J. N. Y. Agrl. Expt. Sta. Tech. Bul. No. 19.

[4] Jordan, Hart and Patten. N. Y. Agr. Expt. Sta. Tech. Bull. No. 1.

[5] Albau and Neuberg. Physiologie und Pathologie des Mineralstoffwechsels.

Increase of organic phosphorus in the ration causes an increased elimination of inorganic phosphorus, the quantity of outgoing organic phosphorus being but slightly affected by the intake of organic phosphorus.

Increased phosphorus elimination is, in the herbivora, mostly by way of the intestines.

A large intake of phosphorus causes a retention of this element.

When the phosphorus given is insufficient in quantity the organism uses for its normal functions the phosphorus previously stored in the body, or that which is not serving an immediately vital purpose.

These results substantiate work done in other laboratories.

The following results which were also noted suggest other possible conclusions. These, if verified, would constitute new contributions to our knowledge and are of fundamental interest:

Sudden withdrawal of phosphorus from the ration causes dryer and firmer feces, sometimes constipation.

The volume of the urine varies directly with the quantity of phosphorus insoluble in 0.2 per ct. hydrochloric acid, and indirectly with the phosphorus soluble in this reagent.

The milk flow increases with the withdrawal of phosphorus and decreases when phosphorus is added to the ration.

Increase of phosphorus in the ration increases the fat in the milk, and vice versa.

These results were pronounced and consistent and must therefore be due to the differences produced in the wheat bran by leaching it with water. By this process, several substances were removed from the wheat bran; some protein, a small amount of carbohydrate, magnesium, potassium and phosphorus. The loss in the protein was made good by an equivalent amount in the form of wheat gluten; that in carbohydrate was deemed negligible. The largest differences were in the amounts of magnesium, potassium and phosphorus. Of these variable factors in the experiment, the phosphorus, in the form of phytin, was thought to be the most significant; the magnesium and calcium are probably combined with the phosphorus in the phytin. Following this suggestive clue, the plans so developed as to include other experiments in which the phosphorus would be made more definitely the variable factor by adding some salt or combination of salts of phytin to a basal ration of a very low phosphorus content, and thus discover specifically what forms of phosphorus, or combinations of bases with phosphorus, are responsible for these striking physiological effects. Inasmuch as calcium phytate can be bought in the market, and is also a single basic salt and therefore presents a simpler problem than the double salts, offering only two variable elements, it was chosen for the next experiment, which is the subject of the present report.

FOURTH EXPERIMENT.

PLAN.

The cow used in experiment II proved to be a hardy animal, a good milker, and hearty eater, by far the most suitable animal in the herd, and was therefore chosen as the subject of this experiment. When the work began she weighed 495 Ko. and gave nine and one-half kilos of milk. She did not come in regularly, but aborted on February 7. By April 11 she had been adjusted to the following ration: oat straw 4,536 grams, rice meal 2,724 grams, wheat bran 4,536 grams, wheat gluten 597 grams, which gives a total of 249.6 grams nitrogen, and 66.5 grams of phosphorus, 51.1 grams of the latter being in the form of phytin phosphorus. She was then removed from the herd and placed in a comfortable room planned for metabolism work, and after eighteen days on the ration as given above, samples for analysis were taken daily. The days of the experiment were numbered consecutively from the first day of sampling, April 29, to the end of the experiment, eighty-five days later. In the laboratory the samples were known by these numbers. The time was divided into five main periods with transition periods between each two as follows:

Period I, days 1–6 (April 29–May 4), The whole wheat bran period, with the ration as specified above;

Transition period, days 7–10, in which the whole bran was gradually replaced by washed bran;

Period II, days 11–19 (May 9–May 17), The phosphorus equilibrium period, in which the intake and outgo of phosphorus were approximately the same, 24.2 grams per day.

Period III, days 23–33 (May 21–May 31), The low phosphorus period in which the phosphorus was reduced to fifteen grams;

Transition period, on the thirty-fourth day, 50 grams of calcium phytate were added to this ration, this salt was increased to 125 grams on the next day;

Period IV, days 36–45 (June 3–June 12), The calcium phytate period, which was the same as the preceding period (III) plus one hundred and seventy-five grams of calcium phytate;

Transition period, days 46–50, in which decreasing amounts of the phytate were added to the ration;

Period V, days 51–78 (June 18–July 15), The protracted low-phosphorus period in which the ration was the same as that offered in Period III.

The plan included a sixth period identical with the first, in which striking results were anticipated as consequence of the change from the long continued low-phosphorus ration to one high in this element, but pathological conditions developed and the animal was perforce discharged on the eighty-sixth day.

In this plan we think we have maintained as nearly as possible constant conditions with respect to all factors involved, except the soluble bran constituents which were purposely changed at the end of the first and fifth periods and the addition of calcium phytate in Period IV. The salient points in the plan of the experiments are: a large decrease of total phosphorus, including soluble organic phosphorus and inorganic phosphorus; a decrease of magnesium and of potassium in the rations at the end of the first period, and an increase of calcium and phosphorus during the fourth period. This made the first and fourth periods high in phosphorus intake, and the others low, and the fourth distinguished from the first by having calcium phytate added to a ration, otherwise low in phosphorus.

THE EXPERIMENT IN PROGRESS.

In regard to the details, the management of the experiment was as like that reported in Technical Bulletin No. 1 of this Station, page 5 et seq., as it could practically be made. The division between the days was made at seven o'clock in the morning. The cow was milked twice a day instead of three times. The attendants for the cow were the same men as were employed for this purpose in the previous experiments.

The components of the rations were separately mixed and weighed into paper bags, at which time the samples were taken. The oat straw was a baled article purchased in the local market. Two separate batches of straw were used, the first (F6) lasting from April 11 to June 2, the other (F14) from June 3 to the end of the experiment. These differed somewhat in their analysis, as is shown in Table 1. Large quantities of wheat bran were extracted with water and dried (F5). The original bran (F2) contained 1.48 per ct. of total phosphorus, of which 73 per ct. of the phosphorus was soluble in 0.2 per ct. hydrochloric acid; the washed bran (F5) used in the second period had a total phosphorus content of 0.326 per ct. This latter bran was later rewashed (F11, F12, F13) and the phosphorus reduced to only 0.123 per ct.; this was used in the last three periods. The rice was of good quality, well polished and therefore low in ash constituents. It was ground in a local mill and weighed up at three different times (F7, F9, F15). The analyses of the samples agreed well with one another, and the values used are an average of the three. The wheat gluten was weighed up from two lots (F10, F36), the latter being introduced in the fifth period. It contained a little more moisture and calcium phosphate but did not differ enough from the first to affect the problem materially. The largest discrepancies introduced by the renewal of the components of the rations are those in the straw, which in terms of grams per day are: Total phosphorus 0.63, soluble phosphorus 0.36, inorganic phosphorus 1.45.

TABLE I.— MINERAL CONSTITUENTS OF FEEDS USED.

FEED.	Amount	Nitrogen.	Phosphorus.			Calcium.	Magnesium.	Potassium.
			Total.	Soluble.	Inorganic.			
	Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Straw (F 6).....	4,536	0.40	0.122	0.085	0.045	0.41	0.153	0.954
(F 14)....	4,536	0.38	0.108	0.093	0.077	0.35	0.150	0.941
Rice...........	2,724	1.25	0.083	0.036	0.014	0.09	0.020	0.025
Gluten* (F 10)..	.....	13.25	0.220	0.094	0.034	0.38	0.050	0.043
(F 36)..	.....	12.52	0.196	0.055	0.040	0.20	0.033	0.030
Bran (F 2)......	4,536	2.60	1.485	1.080	0.014	0.14	0.540	1.380
(F 5)......	4,536	2.02	0.326	0.112	0.056	.....	.....	......
(F 12).....	4,536	1.89	0.123	0.039	0.005	0.37	0.080	0.075
Phytin.........	175	.....	20.32	20.32	2.00	11.87	0.550	......

* Fed in period I 597 grams, II, III, IV, 796 grams, V 530 grams.

The animal was given plenty of protein and carbohydrate and ate her rations well until the seventeenth day, when she began to refuse varying amounts of feeds which were carefully gathered up and analyzed, and the daily ration corrected accordingly. The actual intake of the elements studied is given in Table II. This

TABLE II.— NITROGEN AND PHOSPHORUS INGESTED.

PERIOD.	Days		Average Daily Consumption of					
			Nitrogen total.	Phosphorus.				
				Total.	Soluble.	Insoluble	Phytin.	Inorganic.
			Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
I............	1–6	April 29 to May 1	249.7	76.5	54.4	22.1	51.1	3.3
II............	11–14	May 9	249.3	24.2	10.7	13.5	5.4	5.3
	13–17	to	247.2	24.0	10.6	13.4	5.4	5.2
	16–19	May 17	246.0	23.9	10.5	13.4	5.3	5.2
III............	25–29	May 23	215.6	12.6	5.9	6.7	3.6	2.3
	27–31	to	192.0	12.6	5.8	6.8	3.4	2.4
	29–32	May 30	213.3	13.4	6.3	7.1	3.7	2.6
IV...........	39–42	June 6	184.0	41.6	39.2	2.4	32.7	6.5
	42–45	to	179.0	46.1	42.2	3.9	35.3	6.9
	36–45	June 12	190.3	43.8	40.0	3.8	32.7	6.9
V...........	51–56	.....	201.8	13.6	7.2	5.9	2.6	4.0
	59–64	June 26	167.2	11.0	5.4	5.6	2.7	3.7
	66–71	to	184.2	11.7	6.7	5.0	2.8	3.9
	72–77	July 14	193.3	13.0	7.0	6.0	3.2	3.9

refusal of part of the ration may have been due to an excess over her requirements and desires but was more probably due to her dislike for the washed bran and rice, and in the fourth and fifth periods to physiological disturbances. By the end of the fourth period she left such large quantities untouched that it was deemed advisable to decrease some of the rations.

COLLECTION AND TABULATION OF DATA.

The methods of sampling and analysis were the same as those given in Technical Bulletin No. 1. There were altogether 1,998 analyses recorded, mostly done in duplicate and a few in triplicate. The greatest number of these analyses were made by M. P. Sweeney and J. T. Cusick. This mass of data was tabulated, and in order to facilitate interpretation of results, groups of days have been averaged. These days were chosen before any study of the material had been made in order to eliminate any partiality that might unconsciously creep in.

The cow was kept for eighteen days on the first ration so as to become fully adjusted to it, and the figures for the six following days were averaged as Period I to represent the normal status of the animal. The ration planned to give phosphorus equilibrium covered thirteen days, the last nine of which were divided into three groups. The days of the first low-phosphorus period, also thirteen, were grouped in the same manner. To this ration calcium phytate was

Table III.— Apparent Digestibility* of Nitrogen and Phosphorus.

Days		Nitrogen.		Phosphorus.					
				Total		Insoluble		Phytin	
		Grams.	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Per ct.*
I	1–6	163.0 9.3	65.2	25.9	33.9	11.9	54.2	47.7	93.5
II	11–14	179.3	61.2	10.1	41.8	7.0	49.8	3.6	66.6
	13–17	181.8	61.3	11.7	48.9	6.8	50.0	5.2	96.3
	16–19	170.7	60.9	11.2	46.9	6.7	50.0	3.9	75.1
III	25–29	157.5	73.1	4.4	35.1	2.7	40.3	2.7	75.0
	27–31	131.5	68.5	3.8	30.0	1.3	19.1	2.5	73.9
	29–32	158.2	74.1	5.5	41.2	2.3	32.4	2.3	75.9
IV	39–42	135.2	73.4	24.1	58.0	(—3.1)	.....	33.0	91.1
	42–45	118.5	66.2	22.7	49.2	(—2.8)	.....	31.3	80.0
	36–45	133.1	70.0	24.6	57.2	(—2.7)	.....	31.8	86.7
V	59–64	113.8	67.6	3.2	29.0	1.6	29.8	0.0	0.0
	66–71	121.0	65.6	2.9	24.9	1.6	23.8	1.3	46.5
	72–77	123.6	64.0	4.0	30.0	0.4	7.6	1.6	50.0

* The difference between the amounts of nitrogen and phosphorus in the feces and the rations consumed.

added on the days Nos. 34 to 50, 50 grams on the 34th, 125 grams on the 35th, and 175 grams on each succeeding day until the 50th day, after which the amounts were gradually decreased. Four days were chosen in the middle and four days at the end of this period. Inasmuch as this period (IV) is the main feature of the experiment, an average is also taken of the entire time when the full amount of calcium phytate was added (days 36 to 45). The second low-phosphorus period was prolonged to show the effects of an exaggerated case of phosphorus starvation, and lasted from the 51st day to the 77th day. The average of days 51 to 56 is given to show the first changes induced by the withholding of the phosphorus from the ration, the other groups of days selected were three of six days each at the end of the period. These averages of the days of the several periods are presented in the main tables.

TABLE IV.—INTAKE AND OUTGO OF NITROGEN AND PHOSPHORUS.

A.—NITROGEN.

Period.	Days.	Intake.	Outgo.				Balance.
			Dung.	Urine.	Milk.	Total.	
		Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
I.....	1-6	249.6	86.6	92.9	58.7	238.2	+11.4
II.....	11-14	249.7	70.4	103.2	57.7	231.3	+18.4
	13-17	247.0	65.2	107.8	57.8	230.8	+16.2
	16-19	246.0	75.3	103.9	57.8	236.5	+9.5
III.....	25-29	215.6	58.1	101.1	56.7	215.9	—0.3
	27-31	192.0	60.5	106.8	54.1	221.4	—29.4
	29-32	213.3	55.1	97.8	55.4	208.3	+5.0
IV.....	39-42	184.0	48.8	80.8	46.3	175.9	+8.1
	42-45	179.0	60.5	72.5	48.5	181.5	—3.5
	36-45	190.3	57.2	83.9	50.6	191.7	—1.4
	51-56	201.8	65.3	67.3	54.1	186.7	+15.1
V.....	59-64	167.3	53.5	69.1	45.3	168.	—0.7
	66-71	184.3	63.3	73.6	45.4	182.3	+2.0
	72-77	193.3	69.7	66.2	45.6	181.5	+11.8

B.—TOTAL PHOSPHORUS.

Period.	Days.	Intake.	Dung.	Urine.	Milk.	Total.	Balance.
I.....	1-6	76.5	50.6	2.2	9.5	62.2	+14.2
II.....	11-14	24.2	14.1	0.30	10.6	25.0	—0.8
	13-17	24.0	12.3	0.18	10.8	23.3	+0.7
	16-19	23.9	12.7	0.17	10.8	23.7	+0.2

TABLE IV.— INTAKE AND OUTGO OF NITROGEN AND PHOSPHORUS—*Continued*

B.—TOTAL PHOSPHORUS—*Continued.*

Period.	Days.	Intake.	Outgo. Dung.	Outgo. Urine.	Outgo. Milk.	Outgo. Total.	Balance.
		Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
III.....	25–29	12.6	8.2	0.13	10.5	18.9	—6.3
	27–31	12.6	8.8	0.13	10.5	19.4	—6.8
	29–32	13.4	7.9	0.13	10.3	18.3	—4.9
IV.....	39–42	41.5	17.4	5.3	9.2	31.9	+9.7
	42–45	46.1	23.4	5.7	9.4	38.5	+7.6
	36–45	43.8	19.2	4.0	9.7	32.9	+10.9
	51–56	13.6	10.1	0.11	10.3	20.5	—6.9
V.....	59–64	11.0	7.8	0.15	8.4	16.4	—5.4
	66–71	11.7	8.8	0.11	8.8	17.7	—6.0
	72–77	13.0	9.0	0.18	8.7	17.9	—4.9
			C.—SOLUBLE PHOSPHORUS.				
I.....	1-6	54.4	40.4	2.2	7.0	49.6	+4.8
II.....	11–14	10.7	7.6	0.30	8.2	16.1	—5.4
	13–17	10.6	5.5	0.18	8.5	14.18	—3.6
	16–19	10.5	6.0	0.17	8.4	14.57	—4.1
III.....	25–29	5.9	3.2	0.13	8.3	11.53	—5.6
	27–31	5.8	3.3	0.13	8.2	11.63	—5.8
	29–32	6.3	3.1	0.13	8.2	11.43	—5.1
IV.....	39–42	39.2	11.9	5.3	7.3	24.5	+14.7
	42–45	42.2	16.6	5.7	7.6	29.9	+12.3
	36–45	40.0	12.7	4.0	7.7	24.4	+15.6
	51–56	6.5	4.7	0.11	7.9	12.7	—6.2
V.....	59–64	5.4	4.0	0.15	6.5	10.7	—5.3
	66–71	6.7	3.7	0.11	6.8	10.6	—3.9
	72–77	7.0	3.4	0.18	6.7	10.3	—3.3
			D.—INSOLUBLE PHOSPHORUS.				
I.....	1-6	22.1	10.2	.....	2.5	12.7	+9.4
II.....	11–14	13.5	13.5	.....	2.4	15.9	—2.4
	13–17	13.4	6.8	.....	2.3	9.1	+4.3
	16–19	13.4	6.7	.....	2.4	9.1	+4.3
III.....	25–29	6.7	5.0	.....	2.2	7.2	—0.5
	27–31	6.8	5.5	.....	2.3	7.8	—1.0
	29–32	7.1	4.8	.....	2.1	6.9	+0.2

TABLE IV.—INTAKE AND OUTGO OF NITROGEN AND PHOSPHORUS—*Continued.*

D.—INSOLUBLE PHOSPHORUS—*Continued.*

Period.	Days.	Intake.	Outgo.				Balance.
			Dung.	Urine.	Milk.	Total.	
		Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
IV.....	39–42	2.4	5.5	.....	1.9	7.4	—5.0
	42–45	3.9	6.8	.....	1.8	8.6	—4.7
	36–45	3.8	6.5	.....	2.0	8.5	—4.7
	51–56	7.1	5.4	.....	2.4	7.8	—0.7
V.....	59–64	5.6	3.8	.....	1.9	5.7	+0.1
	66–71	5.0	5.1	.....	2.0	7.1	—2.1
	72–77	6.0	5.6	.....	2.0	7.6	—1.6
			E.—SOLUBLE ORGANIC PHOSPHORUS.				
I.....	1–6	51.1	3.4	.....	.....	.....	+47.7
II.....	11–14	5.4	1.8	.....	.....	.....	+3.6
	13–17	5.4	0.2	.....	.....	.....	+5.2
	16–19	5.3	1.4	.....	.....	.....	+3.9
III.....	25–29	3.6	0.9	.....	.....	.....	+2.7
	27–31	3.4	0.9	.....	.....	.....	+2.5
	29–32	3.7	0.9	.....	.....	.....	+2.8
IV.....	39–42	36.2	3.2	.....	.....	.....	+33.0
	42–45	38.8	7.5	.....	.....	.....	+31.3
	36–45	36.6	4.8	.....	.....	.....	+31.8
	51–56	2.6	2.2	.....	.....	.....	+0.4
V.....	59–64	1.7	1.8	.....	.....	.....	+0.9
	66–71	2.8	1.5	.....	.....	.....	+1.3
	72–77	3.1	1.6	.....	.....	.....	+1.6
			F.—INORGANIC PHOSPHORUS.				
I.....	1–6	3.3	37.0	2.2	7.0	46.2	—42.9
II.....	11–14	5.3	5.8	0.30	8.2	14.3	—9.0
	13–17	5.2	5.3	0.18	8.5	14.0	—8.8
	16–19	5.2	4.6	0.17	8.4	13.2	—8.0
III.....	25–29	2.3	2.3	0.13	8.3	10.7	—8.4
	27–31	2.4	2.4	0.12	8.2	10.7	—8.3
	29–32	2.6	2.2	0.13	8.2	10.6	—8.0
IV.....	39–42	3.0	8.7	5.3	7.3	21.3	—18.3
	42–45	3.4	9.1	5.7	7.6	22.4	—19.0
	36–45	3.4	7.9	4.0	7.7	19.6	—16.2
	51–56	4.0	2.5	0.11	7.9	10.5	—6.5

TABLE IV.—INTAKE AND OUTGO OF NITROGEN AND PHOSPHORUS—*Concluded.*
F.—INORGANIC PHOSPHORUS—*Concluded.*

Period.	Days.	Intake.	Outgo.				Balance.
			Dung.	Urine.	Milk.	Total.	
		Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
V.....	59–64	3.7	2.2	0.15	6.5	8.8	—5.1
	66–71	3.9	2.2	0.11	6.8	9.1	—5.2
	72–77	3.9	1.8	0.18	6.7	8.7	—4.8

TABLE V.—DISTRIBUTION AND BALANCE OF CALCIUM, MAGNESIUM AND POTASSIUM.

	Days.	Intake.	Outgo in—				Balance.
			Milk.	Urine.	Dung.	Total.	
Calcium:		*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
I..........	1–6	29.5	13.9	0.8	12.4	27.1	+2.4
III..........	23–32	32.5	14.7	2.8	18.4	35.9	—3.4
IV..........	43–45	56.5	12.9	0.6	37.5	51.0	+5.5
V..........	74–77	34.3	13.6	3.3	30.5	47.4	—13.1
Magnesium:							
I..........	1–6	22.2	1.07	5.2	11.3	17.6	+4.6
III..........	23–32	8.7	1.17	4.7	10.1	16.0	—7.3
IV..........	43–45	11.6	1.10	2.0	12.9	16.0	—4.4
V..........	74–77	10.5	1.00	1.8	10.6	13.4	—2.9
Potassium:							
I..........	1–6	106.7	14.2	60.9	56.3	131.4	—24.5
III..........	23–32	46.9	13.4	35.9	26.3	75.6	—28.7
IV..........	43–45	44.4	12.2	42.1	33.2	87.5	—43.1
V..........	74–77	41.6	10.4	49.0	23.2	82.6	—41.0

DISCUSSION OF THE DATA.

Nitrogen.— Jordan, Hart and Patten[1] make the statement that there is no relation whatever between the excretion of phosphorus and nitrogen. Two papers have since appeared which are interesting in this connection. The one reports experiments on four rabbits by Le Clerc and Cook,[2] showing that the addition of inorganic phosphorus to a normal ration increases the nitrogen meta-

[1] Jordan, Hart and Patten, N. Y. Agrl. Expt. Sta. Tech. Bull. No. 1, p. 48.
[2] Le Clerc and Cook, *Jour. Biol. Chem.*, 2: 303, 1906.

bolism, but when the phosphorus is added to a phosphorus-poor diet, the reverse is true. The same results were given by soluble organic phosphorus. These authors state that the phosphorus of bran is very readily absorbed, but that the nitrogen, on the other hand, is utilized very poorly; and quote Girard and Lindet[1] as having arrived at the same conclusion in their work upon rabbits. This, if true, is interesting with respect to the nitrogen in that it shows a marked difference in the nutritive economy among the species of herbivorous animals, for it is the common experience of agricultural chemists that cattle utilize bran proteins very well.[2] In Table III it is shown that our animal assimilated over 60 per ct. of the nitrogenous constituents of the rations, 78 per ct. of which was derived from wheat, and almost half of this from the bran. The other paper relates to an extensive experiment upon rats by Gregersen,[3] in which his purpose was to demonstrate that inorganic phosphorus is synthesized into protein phosphorus by the animal organism. He states definitely that there is a parallelism between the phosphorus and nitrogen elimination.

Sécheret,[4] studying the therapeutic value of phytin, claims that this phosphorus compound stimulates protein metabolism and increases the nitrogen elimination, but this is in direct conflict with the observations of Rogosinski,[5] who also worked on man. This latter author found no relation whatsoever between the protein and phosphorus metabolism when phytin, lecithin, and disodium phosphate were fed.

The experiments of this Station do not show any very striking relationships between these two excreted products; there is, however, an apparent resemblance between the curve of nitrogen and total phosphorus intake and outgo, as is shown in Figure 1. As Le Clerc and Cook state, the addition of phosphorus to a phosphorus-poor ration is followed by a decrease of the nitrogen output, immediately followed by an increase when the addition of phytate phosphorus is discontinued. This parallelism is independent of the relations between the apparent digestibility of the nitrogen and phosphorus, as is shown in Table III. In drawing conclusions from the data of this experiment, it must be borne in mind that the animal was not in nitrogen equilibrium and the amount of rations voluntarily consumed by the cow varied considerably in the latter period of the experiment; however, if we review the former experiments of this series and construct curves for them, we get very much the same

[1] Girard and Lindet Froment et sa monture, 1903.
[2] Jordan and Hall, U. S. Dept. Agr., O. E. S. Bull. 77, p. 79.
[3] Gregersen, *Ztschr. Physiol. Chem.* **71**: 49. 1901.
[4] Sécheret; Thése de Paris, 1904, p. 131, from Maly's *Johrber. Tierchem.*, **34**: 729. 1904.
[5] Rogosinski *Anz. Akad. Wiss. Krakau,* B 1910, p. 260; from *Chem. Centrbl.* **31, II**: 1558. 1910.

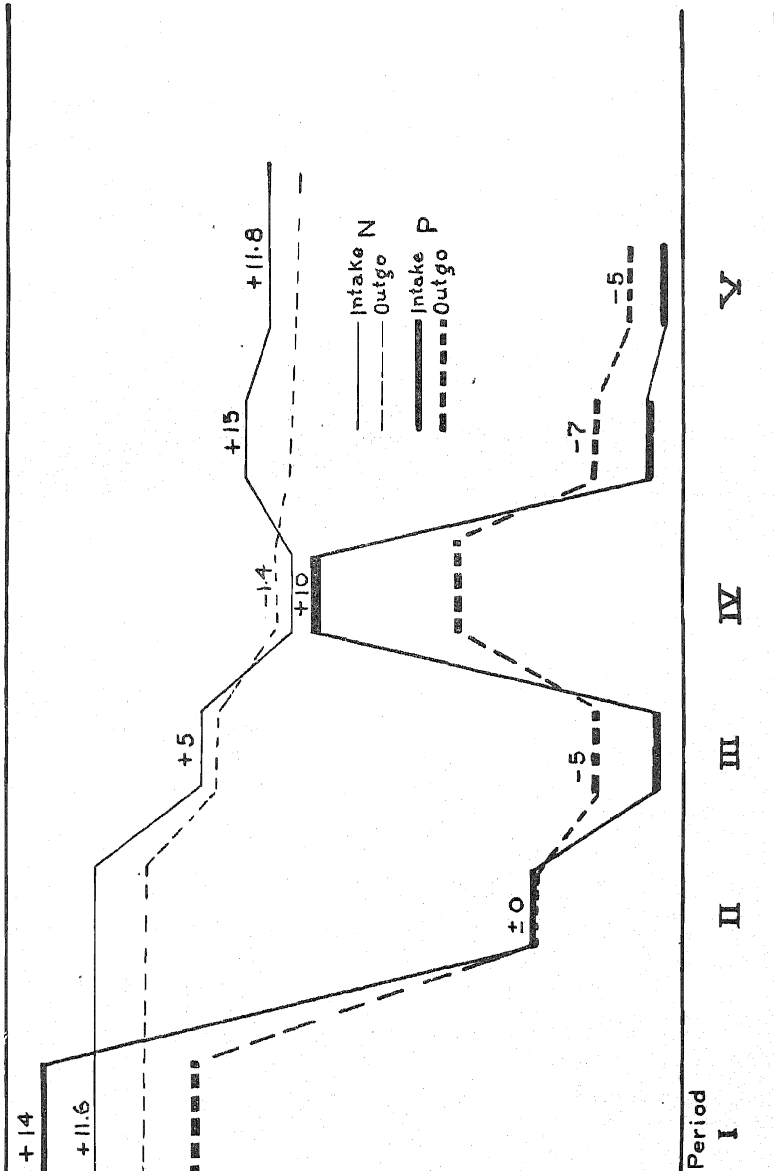


FIG. 1.—RELATION BETWEEN PHOSPHORUS AND NITROGEN METABOLISM.

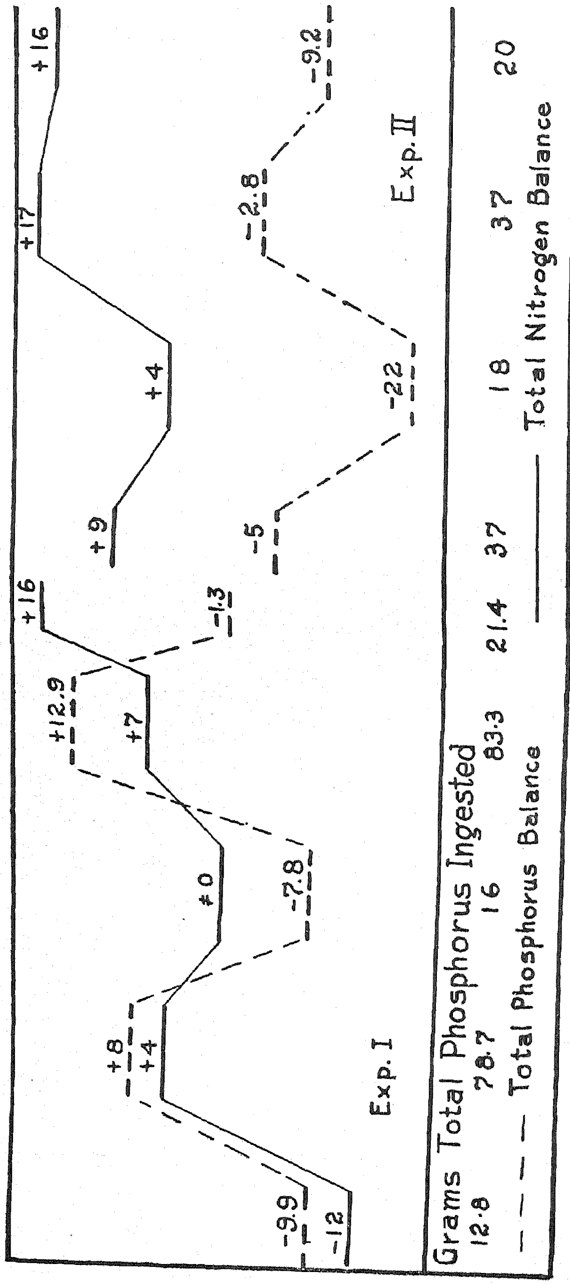


FIG. 2.—RELATION BETWEEN PHOSPHORUS AND NITROGEN BALANCE.
(Constructed from data in Technical Bulletin No. 1.)

picture (Fig. 2). In the first experiment, the intake of nitrogen was almost constant; the results of this experiment differ from those of the fourth experiment in that there exists a parallelism between the apparent digestibility of the nitrogen and the phosphorus intake. This is also true of Experiment Three. The second experiment shows no such parallelism, but this should not be given much weight in the argument inasmuch a new factor (nucleo-protein in the rations) is here involved which might be responsible for the discrepancy. In view of all this, one is almost justified in assuming that there may exist between phosphorus and nitrogen metabolism some intimate relationship involved in the synthesis or cleavage of the nucleoproteins in the organism, but the facts so far established are not sufficient to warrant any conclusion on the fundamental principles here suggested.

Total phosphorus.— The ingested phosphorus was mostly eliminated by way of the intestines. The amount of phosphorus excreted in the urine was relatively very small, as little as one-half of one per ct. of the total outgo of this element on a phosphorus-poor diet. The amount of phosphorus in the urine is readily changed by increasing the phosphorus intake (Period IV, Table IVb), as is evident from the study of the data of the phytin period, where the urine phosphorus rose to 15 per ct. of the total outgo. The response to the change in the ration was immediate. Twenty-five grams of phytin were withheld on the forty-sixth day, the next day's urinary phosphorus was 1.31 grams less than on the preceding day; on the fifty-first day, the phytin intake had been reduced to the minimum and the corresponding urine had 90 per ct. less of phosphorus. The same effects are also shown in the other transition periods. In the days between periods I and II there is an immediate drop of 50 per ct. in response to the substitution of washed bran for whole bran. These cases cited above are those of reduction of phosphorus in the rations. When it is a matter of increase the quantitative change is equally striking, but follows a lag of two days. One set of figures will illustrate this point: On the 36th day, there was 0.3 grams P in the urine; 37th day 0.24 grams; 38th day, 0.23 grams; 39th day, 3.85 grams; 40th day, 44.1 grams P in the urine, the full portion of phytin, 175 grams, having been added on the thirty-seventh day. These quantitative changes of the phosphorus in the urine were not wholly due to the relative total amounts of this element in the rations, but also to the nature of its chemical combination or the internal relations of the phosphorus in the feeds themselves. No other assumption can explain the differences between periods I and IV in which the urine of the former contains less phosphorus than that of the latter, though in its ration there was twice as much phosphorus, and in both periods more than half of the ingested phosphorus was in the form of phytin. In comparing the experiments II and III by Jordan, Hart and Patten,

we have a suggestion of the difference induced by the nature of the chemical combination of the phosphorus in the rations. In Experiment II, which is a study of nucleo-protein phosphorus, there was no change in the phosphorus content of the urine but in the other experiment, which was a phytin problem, there is recorded a drop of 99 per ct. when the soluble organic phosphorus compound is withdrawn. Experiment II should be repeated before definite conclusions are drawn, not only because it is a single experiment, but in that the amount of phosphorus fed in its principal period was too small to maintain even an equilibrium of this element.

The minimum amount of phosphorus in the urine did not occur in the samples from the end of the protracted low-phosphorus period, as one might have expected; the urine of this period was no poorer in phosphorus than that of Period III. The lowest urinary phosphorus occurred in the week following the last feeding of calcium phytate.

From Table IV we see that the animal maintained approximately a phosphorus equilibrium on an intake of twenty-four grams of total phosphorus while giving milk carrying eleven grams of the element, leaving thirteen grams per day for the other physiological functions. The phosphorus requirement aside from the milk production would therefore seem to be about twenty-six milligrams per kilo body weight, as a minimum for this animal. When less phosphorus is given than the organism requires, the physiological functions continue at the expense of the phosphorus previously stored in the tissues of the body. Such a storage takes place when a greater amount of phosphorus than is indicated above is being fed, but this is not in direct proportion to the amounts of the increase as can be readily seen by studying periods I and IV in Table IV. Twenty days of very low phosphorus intake did not materially change the phosphorus balance. This is in harmony with previous experiments.

Insoluble phosphorus.—The insoluble phosphorus was obtained, as in the previous work, by subtracting the soluble phosphorus from the total phosphorus, and was considered, as in the former experiments, to be chiefly nucleo-protein phosphorus. There is less insoluble phosphorus in the washed bran than in the original, because it is carried out mechanically by the water along with considerable starch and gluten.

An inspection of Table IV shows that when the amount of insoluble phosphorus in the ration is changed, the amount of this form of phosphorus in the feces also changes; but when the insoluble phosphorus in the feed is reduced to 13.5 grams per day, further reduction does not result in corresponding decrease in the amount of this form of phosphorus in the dung. The insoluble phosphorus was very largely changed to inorganic phosphorus. This is not apparent when the amount of intake was less than 13.5 grams, as is indicated by the data in the table for the days following number 13, in which

there seems to be an approximate regularity in the excretion of insoluble phosphorus independent of the amount of this form of phosphorus ingested.

Soluble organic phosphorus.—In the organic phosphorus compounds soluble in 0.2 per ct. hydrochloric acid, we have the phytin of the grains and feces and such small amounts of glycero-phosphates as may occur in the feces. The amount of soluble organic phosphorus in the dung is relatively very small, less than 5 per ct. of the total phosphorus passed from the animal body, except in the fifth period when the phytin content of the feces increased. Only a very small amount of phytin is excreted into the milk and urine.[1] It forms less than 3 per ct. of the urinary phosphorus and its presence in the milk has not yet been sufficiently demonstrated. In this experiment, the soluble organic phosphorus in the milk and urine was not deemed significant at the time the analyses were made and its determination therein were omitted. Our study of phytin phosphorus is therefore confined to the figures obtained from the analyses of the rations and feces. In Table III, where these data are recorded, we see a relatively small amount of phytin phosphorus in the feces, even in the first and fourth periods when the phytin intake was 51.1 grams and 36.6 grams per day respectively, from which we must conclude that the phytin disappears from the alimentary tract to a very large extent. It is readily absorbed and in the tissues is hydrolyzed by enzymes and converted into inorganic phosphate and inosite.[2] Any which fails of absorption, or is returned to the intestine after absorption, may also be split by intestinal bacteria, specifically *B. coli*.[3] Rogosinski, whose work was referred to on p. 15 found that human fecal matter completely destroyed phytin. The dog on the other hand eliminated 70 per ct. of the administered phytin without any change in it. The other 30 per ct. was assimilated and a corresponding amount of inorganic phosphorus eliminated in the urine. Hence considering the enormous bacterial flora of the cow's interior it is not surprising to find that only 6.5 per ct. of the soluble organic phosphorus fed in the first period was recovered in the feces. The apparent utilization of the phytin in the calcium phytate period was appreciably less, ranging from 89 to 91 per ct., with one-third more soluble phosphorus in the feces than in the first period, although less phytin was fed. In Table IV, a comparison between the total phosphorus ingested and the phosphorus balance in periods 3, 2 and 4, shows that the output fluctuates with the intake, hence there is a more direct relation between the two than is observed in nitrogen metabolism, in which the balance is not so immediately influenced by the amount ingested. The

[1] Starkenstein. *Biochem.* Ztschr. 30: 56. 1910.
[2] McCallum and Hart, *Jour. Biol. Chem.* 4: 497. 1908.
[3] Unpublished data by the author.

average intake of total phosphorus in the transition period between periods 1 and 2 is 51.2 grams, and the outgo is 46.3 grams, giving a balance less than any in the calcium phytate period with an average ingestion of 43.8 grams of total phosphorus per day. The apparent digestibility of phytin phosphorus in the low-phosphorus period is even less. These figures suggest that the various phytins are not utilized with equal ease, and those which were less readily washed out of the original bran were the more apt to pass through the alimentary tract unchanged. This is purely speculative; more data are required before an intelligent interpretation can be made.

Inorganic phosphorus.— In this experiment, as in the previous work, there was in all cases more inorganic phosphorus eliminated than had been given in the rations. The end product of phosphorus metabolism is inorganic phosphate, which in the herbivora is excreted chiefly by way of the intestinal canal as salts of the alkali earths.[1]

Bases.— In all the periods, more potassium was excreted than was taken into the system. The amount of this element in the bran was reduced by the leaching to which it had been subjected, so that there was, therefore, a lessened intake in the periods during which washed bran was fed, accompanied by a decreased elimination in the feces and urine. On the addition of calcium phytate, there was an increase of potassium in the dung and urine amounting to somewhat more than six grams in each; on the withdrawal of calcium phytate, fecal potassium fell ten grams per daily output but the urinary potassium slightly increased.

The whole-bran period gave a magnesium balance of + 4.6; all the other periods were deficient in this element. The magnesium differed from the calcium and potassium in that the amount in the urine decreased constantly from the first period to the end of the experiment. The decrease was most marked between the third and fourth periods, probably due to the influence of calcium phytate which seemed to draw the magnesium toward the intestinal canal. The fecal magnesium was quite constant, about ten grams per day, except in the fourth period when it seems to have been influenced by the increased calcium intake. At the beginning of the experiment, about half as much magnesium was excreted in the urine as in the feces, but at the end, when the labile magnesium of the body had been largely exhausted, only about one-fifth as much was eliminated in the urine.

The calcium elimination in the urine increased remarkably when the phosphorus intake was diminished, and fell again to its former level when the phosphorus was increased. In the last period, when the low phosphorus ration was given for a long time, the calcium in the urine rose to five times the amount excreted through this channel in the phytin period. The calcium in the dung also in-

[1] According to Berg as tri-basic calcium phosphate, *Biochem. Ztschr.* 30: 107. 1910.

TABLE VI.— AVERAGE STATEMENT OF THE DAILY YIELD AND COMPOSITION OF THE MILK, AND ITS CONTENT OF FAT, NITROGEN AND PHOSPHORUS.

Period.	Day Nos.	Milk.	Fat.	Solids.	Ash.	Total nitrogen.	Casein nitrogen.	Total phosphorus.	Fat.	Nitrogen.	Phosphorus.
		Kilos.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Grams.	Grams.	Grams.
I Whole bran period...	1–6	9.29	3.75	12.9	0.805	0.63	0.47	0.101	346.1	58.7	9.5
II Phosphorus equilibrium period....	11–14	9.83	3.8	12.92	0.805	0.59	0.45	0.111	372.3	57.7	10.6
	13–17	9.55	3.76	12.95	0.797	0.60	0.46	0.112	362.3	57.8	10.8
	16–19	9.73	3.8	12.97	0.807	0.60	0.47	0.111	369.6	57.3	10.8
	11–19										
III Low phosphorus period...........	25–29	9.82	3.16	12.23	0.859	0.57	0.436	0.107	310.1	55.7	10.5
	27–31	9.91	3.20	12.14	0.865	0.57	0.436	0.107	307.7	56.0	10.5
	29–32	9.77	3.05	12.34	0.863	0.57	0.436	0.106	302.3	55.4	10.3
	23–32										
IV Calcium phytate period...........	36–40	9.15	3.46	12.26	0.854	0.58	0.430	0.109	314.9	53.2	10.4
	39–42	8.34	3.70	12.32	0.840	0.555	0.430	0.111	308.5	46.3	9.2
	42–45	8.83	3.50	12.58	0.859	0.555	0.440	0.109	308.6	48.5	9.4
	36–45	8.99	3.50	12.43	0.849	0.560	0.430	0.109	314.7	50.6	9.7
V Protracted low phosphorus period...	51–56	9.50	3.6	12.64	0.840	0.57	0.45	0.108	340.3	54.1	10.3
	59–64	8.33	3.6	12.25	0.825	0.55	0.43	0.102	290.4	45.3	8.4
	66–71	8.28	3.4	12.24	0.816	0.55	0.43	0.107	280.8	45.4	8.8
	72–77	8.44	3.25	12.22	0.833	0.54	0.43	0.103	277.8	45.6	8.7

creased with the decrease of phosphorus. The increase in the calcium of the feces in the calcium-phytate period was equivalent to about the amount of calcium increase in the ration. In the last period, the calcium was very much in excess of the calcium in the feces of the first two periods.

INFLUENCE OF PHOSPHORUS ON THE MILK.

The remarkable results of the work reported by Jordan, Hart and Patten in which it was clearly shown that the removal of various compounds from the bran influenced both milk fat and milk flow were confirmed in this experiment, though not in so striking a degree. The data in Table VI are graphically presented in Fig. 3 whose ordinates represent the percentage of fat in the milk, the amount of fat in the milk and the amount of milk flow. The abscissa is not used here for quantitative representation. The base line is divided into parts representing the successive periods, with space for the transition periods, and the amounts of phosphorus given are also indicated here by numerals. Each curve has a different scale and is placed at a convenient distance from the others to facilitate comparison. The top curve (A) represents the percentage of fat in the milk and is drawn to a scale of one-tenth of 1 per ct. to .03 inch; the middle curve (B) represents the total amount of fat and is drawn to a scale of 4 grams to .03 inch; the lowest curve (C) represents the milk yield and is drawn to a scale of fifty grams to .03 inch. For comparison, the results of the previous experiments (by Jordan, Hart and Patten), are plotted in a similar manner (Fig. No. 4). The curves have a general tendency to decline as the period of lactation progresses; this makes the high average yield during the week following the end of the calcium phytate period significant. In all cases where the phosphorus of the ration increases it is immediately followed by a drop in the milk flow, and the withdrawal of phosphorus is followed by a larger yield of milk. Between the week of rapid rise in milk flow which followed the calcium phytate period, and the prolonged low phosphorus period, there is a large decline due to some unknown factor, probably lack of appetite and associated disturbances, but during this low phosphorus period, the milk flow was on a gradual though small increase until the final break which caused the discontinuance of the experiment. These changes are small — from 2 to 20 per ct. in experiments I, II, and III, and from 5 to 7 per ct. in experiment IV — but the results are consistent, with the exception of the last period of experiment III, in which are probably shown the effects of protracted malnutrition. The line representing the fat content of the milk moves up and down regularly as the amount of phosphorus in the ration increases and decreases. The response is in this case also immediate. The change is not a mere matter of fluctuation in

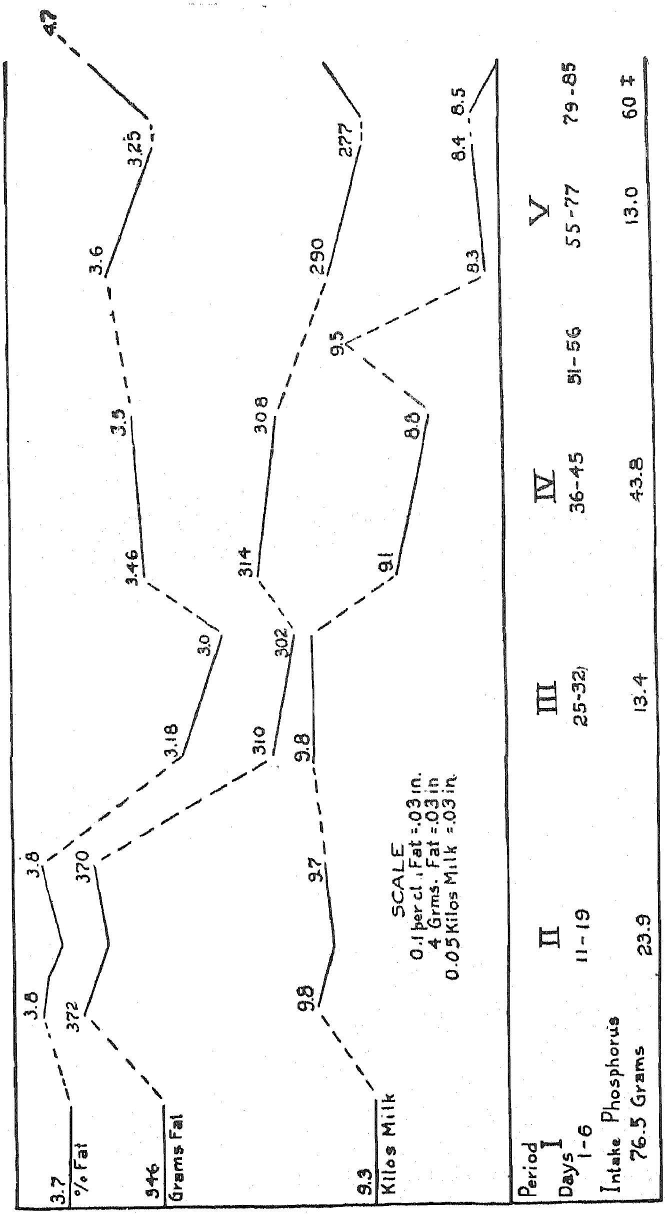


FIG. 3.—INFLUENCE OF PHOSPHORUS INTAKE ON PERCENTAGE AND AMOUNT OF FAT AND MILK FLOW.

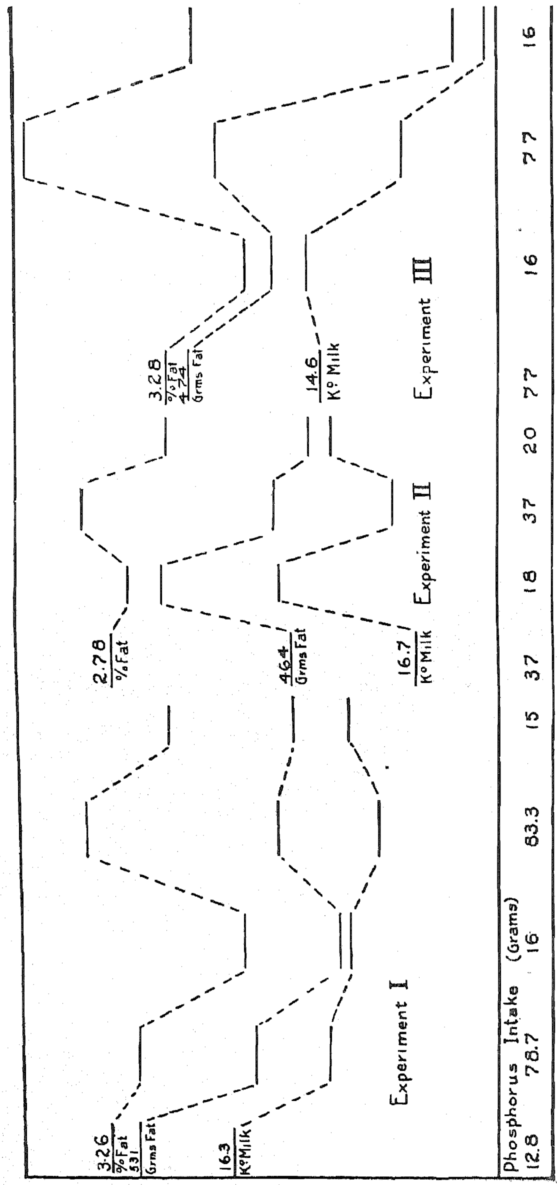


FIG. 4.—INFLUENCE OF PHOSPHORUS ON PERCENTAGE AND AMOUNT OF FAT AND MILK FLOW.
(Constructed from data in Technical Bulletin No. 1.)

water content, but an actual increase of fat secretion by the mammary glands, as is most strikingly shown by the middle line in period 4 of Fig. 3, recording an actual fat increase at the time of a milk decrease. The relative differences in the fat production in the several experiments, induced by the change in the rations were not constant. In experiment I this difference amounted to 24 per ct. of the total fat, while in experiments II and III, it was only 5 per cent; in experiment IV the differences in the fat output of the several periods were relatively greater than in the previous work, but the largest difference was less than the largest difference in experiment I.

The period of phosphorus equilibrium shows the most favorable fat and milk production, which in this particular instance amounts to seven ounces fat and two and one-half pounds of milk per week in excess of the production on the normal rations. This can readily be explained by the assumption that the change in the ration was sufficient to change the milk flow but not enough to lower the relative amount of fat in the milk. If further experiments establish this as a physiological fact it will be interesting scientifically and practically suggestive.

Aside from the fat, the tables show but a relatively small change in the composition of the milk. Since the fat has been shown to vary with the rations, it should be deducted from the total solids, before a study of the solids is undertaken. In Table VII, in which the average composition of the milk for each period is given, the fat-free solids and the fat-free, ash-free solids are listed in columns six and eight. The differences between the percentages are small for both the solids and the ash. The small variations seem to follow the changes in the milk flow, so that the actual increase in the milk solids resulting from the decrease in the phosphorus in the ration is somewhat more pronounced than the changes in the milk volume, the same being true of the decrease when calcium phytate was added. The increased milk flow may therefore be considered as a true secretion of milk and not a mere dilution analogous to polyuria.

TABLE VII.— YIELD AND COMPOSITION OF THE MILK IN THE SEVERAL PERIODS.

Day Nos.	Milk.	Fat.	Solids.	Fat-free solids.	Ash.	Fat-free, ash-free solids.	Total nitrogen.	Casein nitrogen.	P.	Ca.	K.	Mg.
	Kgs.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
I 1-6 ...	9.29	3.75	12.9	9.15	0.805	8.3	0.63	0.47	1.01	0.147	0.155	0.011
II16-19...	9.73	3.8	12.97	9.17	0.807	8.36	0.60	0.47	1.11	......	......	......
III29-32...	9.77	3.05	12.34	9.29	0.863	8.44	0.57	0.44	1.06	0.144	0.130	0.011
IV36-45...	8.99	3.50	12.43	8.93	0.849	8.05	0.56	0.43	1.09	0.145	0.136	0.012
V51-56...	9.50	3.60	12.64	9.04	0.840	8.2	0.57	0.45	1.06	......	......	......
V72-77...	8.44	3.25	12.22	8.97	0.833	8.2	0.54	0.43	1.03	0.159	0.124	0.013

The tendency of the ash is to follow the milk solids. The several components of the ash mentioned in the table may be considered as constant, with the exception of potassium, which seems to decrease slightly throughout the experiment. On the 79th day, whole bran was introduced into the ration, and according to the data in the previous periods, one would expect a decrease in the milk flow and milk solids. The volume of milk had been decreasing throughout the long preceding period and no marked change was noted in the milk flow which could be ascribed to the whole bran; the solids, however, increased on the 82d day. This is obviously a different matter from the former fluctuations in the milk solids, and may be likened to the phenomena commonly observed at the end of a period of lactation. The analytical data for this period are as follows:

Number of day............	77	78	79	80	81	82	83	84
Percentage of fat..........	3.25	3.35	3.25	3.2	3.6	3.8	4.4	4.7
Percentage of fat-free solids.	9.0	8.80	9.10	8.9	8.8	9.0	9.2	9.5

The percentages of total and casein nitrogen show very small but gradually decreasing values throughout the five periods, which is in contrast to the three former experiments of this series in which a small but gradual increase is indicated. These authors stated that aside from the change in the fat content there was no influence

TABLE VIII.—ANALYSIS OF MILK FOLLOWING PERIOD V; RATIONS THE SAME AS IN PERIOD I.

DAY.	Fat.	Solids.	Ash.	Total N.	Casein N.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
78....................	3.35	12.12	0.810	0.55	0.43
79....................	3.15	12.26	0.863	0.55	0.44
80....................	3.20	12.15	0.840	0.56	0.44
81....................	3.6	12.37	0.803	0.57	0.44
82....................	3.8	12.88	0.848	0.55	0.45
83....................	4.4	13.67	0.777	0.57	0.44
84....................	4.7	13.24	0.825	0.55	0.44

TABLE IX.—AVERAGE PER DAY OF THE ASH CONSTITUENTS IN THE MILK.

Period.	K.	Ca.	Mg.	K.	Ca.	Mg.
	Per ct.	*Per ct.*	*Per ct.*	*Grams.*	*Grams.*	*Grams.*
I.... ...	0.155	0.147	0.011	14.19	13.88	1.07
III........	0.130	0.144	0.012	13.34	14.07	1.19
IV........	0.136	0.145	0.013	12.20	12.91	1.11
V	0.124	0.159	0 012	10.41	13.61	1.02

on the milk due to changes of the amount of phosphorus in the ration. Their tables justify such a conclusion; for in only one instance is there such a relation, namely in the fifth period of experiment I, where the following quantities are recorded:

Phosphorus fed......	83.3	21.4	80.7	grams
Fat-free solids.......	8.3	8.6	8.2	per cent

If a change is induced in the composition of the milk by the variation of the phosphorus of the diet, we would expect this to affect the casein, but in all four experiments the casein varies but little and in no definite relation to the phosphorus intake. The other organic phosphorus compound of the milk, lecithin, was not determined. If we return to the total phosphorus and recalculate these amounts to a fat-free milk, we obtain the following percentages:

Period	I	II	III	IV	V
Phosphorus...............	0.107	0.115	0.108	0.113	0.106

This makes a maximum difference of 0.009 per ct. Similar calculation of the data from the experiments reported in Technical Bulletin No. 1, gives:

Experiment	I					II				III	
Grams P in rations	12 8	78.7	16.0	83.3	21.4	37.0	18.0	37.0	20.0	77.0	16.0
Percentage of P in fat-free milk....	0.090	0.089	0.086	0.083	0.090	0.108	0.108	0.107	0.110	0.104	0.110

or a maximum difference for the two animals of only 0.032 per ct. and for the one animal, "Nancy," used in experiments II, III and IV of only 0.011 per ct. which may well be considered within the limits of unavoidable error. This suggests that the phosphorus contents of the solids vary with the individual animal and not with the phosphorus content of the rations fed.

Until more evidence to the contrary has been brought forth we may safely assume that the fat is the only milk constituent changed by alteration of the phosphorus content of the rations, and that there is a definite relation between the phosphorus supply and the yield of milk and butter fat.

It has not been conclusively proven that all the changes noted in the milk production are due *specifically* to *phytin phosphorus* but the evidence warrants the assumption that this substance is in whole or in part responsible for the phenomena observed. When further experiments which have been planned for this series are completed it is hoped that the evidence will show more definitely just what part the phytin salts as a whole, or its cations and anion will play in the physiological functions of the milk cow and how the associated bran extractives may modify this action.

INFLUENCE OF PHOSPHORUS ON EXCRETA

There were in this experiment no gross changes in the nature of the dung like those reported in the previous experiment but changes

in the weight of the samples dried at 60° C. indicate different moisture-content of the feces of the several periods. This bears no relation to the consumption of water nor to the total phosphorus of the ration as is shown by the following figures:

Period	I	II	III	IV	V
Water intake, kilos.........	42.3	44.3	40.0	42.0	42.1
Phosphorus intake, grams...	76.5	24.0	13.4	43.8	13
Water in feces, kilos........	20.0	18.0	17.6	15.7	20.0
Water in feces, per ct.......	86.0	81.5	83.5	79.3	82.8

From experiences in past work in this Station, one would expect dryer feces to result from the change from a whole-bran ration to one in which the bran was washed. This we see to be the case if we examine the eighth column of Table X. The moisture of the feces drops gradually, in a four-day lag, from 86 per ct. in period I to 81.5 per ct. in period II. With a further decrease of the phosphorus in the ration, the moisture of the feces rose instead of

TABLE X.—INTAKE AND OUTGO OF WATER.

Period.	Days.	Water.					Per-centage in dung.	Difference between intake and outgo.	Atmospheric temp.*
		Intake.	Outgo in—			Total outgo re-corded.			
			Milk.	Urine.	Dung.				
		Kgs.	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*	*Per ct.*	*Kgs.*	° F.
I	1–6	42.3	8.28	9.39	20.1	37.5	86	4.8	62.5°
II	13–17	44.2	8.34	8.09	17.4	33.8	81.7	10.4	79°
	16–19	44.5	8.46	7.36	18.6	34.4	81.4	10.1	78°
III	27–31	39.7	8.61	7.98	17.8	33.8	83.5	5.9	62°
	29–32	40.2	8.64	7.62	17.4	33.6	83.4	6.6	61°
IV	42–45	42.7	7.72	7.52	15.4	30.6	79.1	12.1	70°
	36–45	41.2	7.83	7.30	16.0	31.1	79.5	10.1	68°
V	66–71	42.2	7.15	6.22	19.7	33.0	82.9	9.2	81°
	72–77	42.1	7.35	6.88	20.0	34.5	82.6	7.6	80°

* The temperature recorded was kindly furnished by Mr. Newell and is the average maximum per day, taken in a shaded and properly ventilated place about 150 feet from the metabolism room.

becoming less, though the animal took in 4.3 kilos less of water per day. The laxative effect observed in previous experiments was probably due to some other factors than the phosphorus compounds or potassium and magnesium. The ingestion of phosphorus, potas-

sium and magnesium was about the same in the fifth period as in the third; a little more water was consumed but the feces were somewhat drier. If the laxative effect of wheat bran is due to the phytin anion, one would expect a wetter feces in the fourth period when 175 grams of calcium phytate was administered with the rations, but the dung of this period contained less water than that of any other. It is interesting to note however that the average moisture content of the dung of the second four days after the beginning of the phytate feeding was 87.6 per ct. but it soon dropped and gave an average for the period of less than eighty per ct. It is a peculiar incident that the cow desired more water when the moisture in each hundred grams of feces became less. The intake of water seems not to influence the amount of this substance passed out through the intestine.

It has been noted above that the volume of the milk changed in an inverse order to the amount of phosphorus intake, as may be seen from the table of water intake and outgo. (Table X.) The volume of urine shows no parallelism either with the amounts of phosphorus or of water ingested and therefore differs from previous experience in this series of problems. It is probably another peculiar coincidence that the water intake and water outgo in the urine if plotted give curves which run in opposite directions to one another. There is however a suggestion that the urine fluctuates inversely with the temperature of the atmosphere, which is probably accounted for by differences in the amount of perspiration. A curve plotted from the figures obtained by subtracting the values for the water content of dung, urine and milk from those for the water content of the ration (column 9, Table VIII) resembles a similar curve plotted for the atmospheric temperature during the time of the experiment. In the fourth and fifth periods the differences between the temperature and the water balance are such as to lead one to suspect a marked retention of water. The moisture elations in the problem are probably significant, but under the circumstances, inasmuch as a calorimeter was not available, actual determinations could not be made, and a true water balance is therefore impossible.

GENERAL PHYSIOLOGICAL CONDITION.

At the beginning of the experiment, the animal was in good health, and the rations were so planned that she should have an abundance both of protein and carbohydrates. During the experiment, the cow gained 19 kilos in body weight. At first she ate well, cleaning up all the rations offered, but beginning with the 17th day, ten days after washed bran had first been administered in place of the whole bran, she refused varying amounts of feed. The introduction of small amounts of aromatic substances did not seem to

improve the ration from the cow's point of view. At first the amounts refused were small and irregular, but as the experiment progressed, they became increasingly larger and occurred every day, so that it was deemed advisable to decrease the rations in the fourth period. The lack of appetite was at first considered as a natural aversion on the part of the animal to the ration. But as she ate the ration during the first week with relish such aversion must then have developed from monotony. It is more probable, however, that there was no real dislike for the food but a decreased appetite due to physiological disturbances. Certain remarks of Professor Mendel in a recent public lecture suggested this idea. These were based on his observations on experiments with rats and the data reported by Hart and McCollum. In Science for November 24, 1911, the following sentences occur in Mendel and Osborne's article: "And whereas nutritive decline has commonly been attributed to the anorexia consequent upon the monotony of diet, we are more than ever inclined to shift the explanation in many such cases to malnutrition as a primary cause. From this point of view improper diet and malnutrition may be the occasion rather than the outcome of the failure to eat — a distinction perhaps not sufficiently recognized heretofore." The interesting and significant data obtained by Mendel and Osborne are published in Carnegie Institution Publications No. 156. Hart & McCollum's data are published as Research Bulletin No. 17 of the Wisconsin Agricultural Experiment Station. The addition of calcium phytate did not mitigate the situation. Up to the fifth period, the animal showed no outward signs of constitutional disturbance except this constant decrease of appetite but by the close of this period untoward symptoms resulted from the protracted malnutrition. It is interesting to note that the weight of the cow increased eleven kilos during the last period, which, judged by her appetite, was the least promising period in the whole experiment. The increase in weight during the first two periods was almost at the rate of one kilo per day; for the next thirty-four days, i. e., to the end of the fourth period, the weight remained approximately constant, in the last period, the average weight was nine kilos more than in the two preceding periods. Of the total increase in weight during the whole experiment, less than half can be accounted for by the nitrogen balance. From the eightieth day, the animal began to develop pathological conditions, difficult to describe, but perfectly apparent to the men on the farm familiar with live stock. She seemed in good flesh and showed a glossy coat but refused to eat, manifesting positive distaste for her food. Her limbs became stiff and somewhat enlarged about the joints, and her movements were decidedly awkward. She was prone to lie down and had difficulty in getting upon her feet. There was no disturbance of the oestrum throughout the

experiment. The milk flow, which had begun to decrease on the seventy-seventh day, dropped rapidly to four kilos. As it was not permissible to slaughter the animal nor cause her permanent injury, the experiment was closed on the eighty-sixth day, and the cow removed to a box stall where she was given a plentiful supply of alfalfa and silage and whole bran. In the course of a week there were no more signs of malnutrition; she maintained the weight she had gained, the stiffness passed off, and the milk flow increased according to the following records kindly furnished by Mr. Smith, Station Dairy Expert.

Date	Number of days	Amount of milk
July 23	86	3.76 kilos
25	88	3.90
26	89	4.89
27	90	5.62
28	91	5.99
29	92	6.67

PHYTIN AND PHOSPHORIC ACID ESTERS OF INOSITE.*

R. J. ANDERSON.

SUMMARY.

1. The barium salt of phytic acid, $C_6H_{24}O_{27}P_6$, obtained from very dilute hydrochloric acid or 10 per ct. phytic-acid solutions corresponds to the general formula $C_6H_{18}O_{27}P_6M_3$. Apparently the same relation holds for other binary cases.
2. From neutral or alkaline solutions salts of the general formula $C_6H_{12}O_{27}P_6M_6$ are obtained.
3. From very dilute acetic-acid solutions intermediate salts are formed.
4. The acids isolated from the organic-phosphorus compound known as phytin, derived from different sources, have been shown to be identical. The constitution of the substance, however, still remains in doubt.
5. Attempts to synthesize phytic acid by acting on inosite with dry phosphoric-acid in vacuum at 140°–160° C. failed. In this reaction the tetra-phosphoric acid ester of inosite was produced.
6. The tetra-phosphoric ester was found to be very similar to phytic acid. Its barium salt obtained from very dilute hydrochloric acid solutions corresponds to the general formula $C_6H_6(OH)_2O_4[(PO_3H)_2M]_2$.

PREVIOUS INVESTIGATIONS.

In continuation of the physiological investigation concerning the metabolism of the organic-phosphorus compound known as phytin, which has been and is being carried out at this institution by Dr. Jordan, a closer study of the chemical properties of this substance, phytin, became necessary. Much work has already been done and reported on this subject by various investigators. Definite information, however, concerning different kinds of salts formed by the free phytic acid or inosite phosphoric acid is seldom met with in the literature. Frequently impure salts have been analyzed.

Posternak, who first successfully prepared phytin in pure form,[1] also studied its chemical properties. Among the salts mentioned[2] is one, calcium-magnesium, as well as one crystalline, calcium-sodium, double salt, for which he gives the formula $2C_2H_4P_2O_9Na_4+C_2H_4P_2Ca_2+8H_2O$. Winterstein[3] describes a calcium-magnesium compound which, after removing the calcium with oxalic acid and precipitating with alcohol, contained 42.24 per ct. P_2O_5 and 12.97 per ct. MgO. Patten and Hart,[4] working in this laboratory, isolated from wheat bran an impure magnesium-calcium-potassium com-

[1] *Rev. gen. Bot.* 12: 5; *Compt. Rend.* 137: 202.
[2] *Compt. Rend.* 137: 337 and 439.
[3] *Ber. deut. chem. Ges.* 30: 2299.
[4] *Amer. Chem. Journal* 31: 566.
*A reprint of Technical Bulletin No. 19, April, 1912.

pound. Levene[1] describes a semi-crystalline barium salt which corresponds to a tetra-barium phytate. Vorbrodt[2] mentions a crystalline barium salt obtained by partially neutralizing phytic acid with barium hydroxide and evaporating in vacuum, to which he assigns the formula $C_{12}H_{26}O_{46}Ba_7P_{11}$. Although crystalline, this compound was undoubtedly impure. By neutralizing the mother-liquor from the above with barium hydroxide he obtained an amorphous precipitate of the composition C 5.75 per ct., H 0.77 per ct., Ba 52.97 per ct., P 11.60 per ct. This corresponds approximately with a hexa-barium phytate.

Of the several salts mentioned in this paper some were obtained from commercial phytin and from an organic-phosphorus magnesium compound by precipitating with barium chloride and barium hydroxide; others were prepared from previously purified phytic acid. These products will be more fully described in the experimental part.

The tri-barium phytate, $C_6H_{12}O_9\ [(PO_3H)_2Ba]_3$, is obtained pure as an amorphous white powder by repeatedly precipitating barium phytate in 0.5 per ct. hydrochloric acid with a like volume of alcohol. It may also be obtained in crystalline form by dissolving the amorphous salt in a 10 per ct. solution of phytic acid in which it is very soluble and from which it again slowly crystallizes out on standing at ordinary temperature.

A penta-barium phytate, $C_6H_{14}O_{27}P_6Ba_5$, is obtained when a solution of the tri-barium phytate in 0.5 per ct. hydrochloric acid is neutralized with barium hydroxide and then made faintly acid with acetic acid.

The penta-barium ammonium phytate, $C_6H_{12}O_{27}P_6Ba_5(NH_4)_2$, is obtained when the above mentioned amorphous tri-barium salt is digested with dilute ammonia.

The penta-magnesium ammonium phytate, $C_6H_{12}O_{27}P_6Mg_5(NH_4)_2$, is thrown down as a white amorphous precipitate when excess of magnesia mixture is added to an aqueous solution of phytic acid, or when ammonium phytate is precipitated with magnesia mixture.

A tetra-cupric di-calcium phytate, $C_6H_{12}O_{27}P_6Cu_4Ca_2$, in nearly pure form is obtained when a slightly acid solution of calcium ammonium phytate is precipitated with excess of copper acetate. If the magnesium ammonium phytate is precipitated under the same conditions an impure compound is obtained which contains about 1 per ct. Mg, 0.6 per ct. N, 34 per ct. Cu and 15.6 per ct. P. No effort was made to obtain these salts pure. It was only desired to find out to what extent other bases were removed when precipitating with copper acetate.

Starkenstein[3] claims that commercial phytin always contains free inosite together with inorganic phosphates and that merely drying the substance at 100° C. causes nearly complete decomposition into inorganic phosphate and free inosite.

That phytin is so easily decomposed seemed very improbable, as several months' work on the substance has shown that it is relatively

[1] *Biochem. Ztschr.* 16: 399.
[2] *Anzeiger Akad. Wiss. Krakau* 1910, Series A: 414.
[3] *Biochem. Ztschr.* 30: 59.

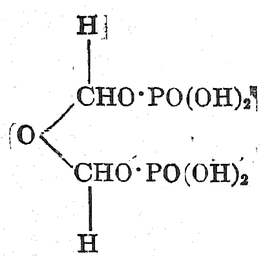
stable when pure and when no mineral acids are present. Moreover, Contardi[1] reports that when phytin is heated in an autoclave with pure water for several hours to a temperature of 200° C. only very small quantities of inosite could be isolated.

In order to determine if inosite is present in determinable quantity 100 gm. of commercial phytin in the form of the acid calcium salt, which had been imported from Europe and kept in the laboratory for several years, was shaken up with 1 liter of water, filtered at once and washed with water. The filtrate was precipitated with barium hydroxide, again filtered and the excess of barium precipitated with carbon dioxide, and the filtrate from the latter evaporated on the water-bath. In the very slight residue which remained, consisting mostly of barium carbonate with a trace of barium chloride, no trace of inosite could be detected by the most painstaking method of isolation. Of the same phytin 100 gm. was dried to constant weight at 115° C. and was then treated in the same manner. Even here no trace of inosite could be obtained. Subjecting to the same treatment 50 gm. of the same phytin, after previously mixing with 0.5 gm. inosite, resulted in the recovery of 0.4 gm. inosite.

This proves that phytin is by no means so easily split as Starkenstein claims. The results in his case may have been due to other causes besides mere drying at 100° C.

The same author (loc. cit.) also states that when phytic acid is precipitated with ammoniacal magnesia mixture it is not the magnesium ammonium compound which is formed, but only the difficultly soluble magnesium phytate. This is an error. Under these conditions the previously mentioned penta-magnesium ammonium phytate, $C_6H_{12}O_{27}P_6Mg_5(NH_4)_2$, is formed.

For the free phytic acid Posternak[2] proposed the empirical formula $C_2H_8O_9P_2$ which he considered to have the following constitution:

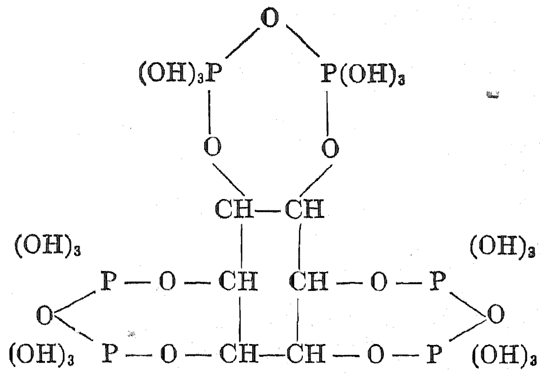


which finds expression in the name "anhydro-oxymethylen diphosphoric acid."

As is well known the free acid, as well as its salts, is easily split under the influence of dilute mineral acids into inosite and orthophosphoric acid. This fact and the discovery by Neuberg[3] that

[1] *Atti R. Accad. dei. Lincei*, Roma (5), 18, I: 64.
[2] *Compt. Rend.* 137: 439.
[3] *Biochem. Ztschr.* 9: 551 and 557.

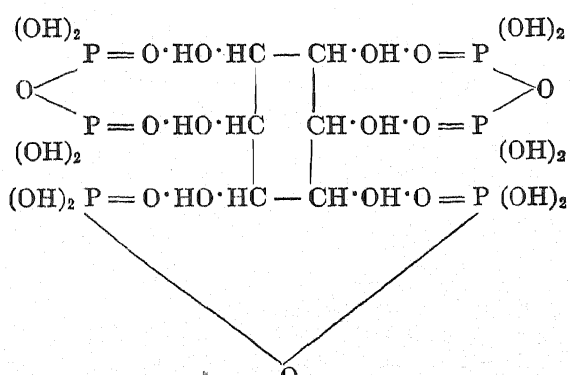
both inosite and phytin yield furfurol when distilled with phosphorus pentoxide and phosphoric acid, respectively, lead him to believe that the inosite ring exists already formed in phytin. In accordance with this view he proposed the following structural formula for the acid:



This is just treble the molecular weight of the anhydro oxymethylen di-phosphoric acid of Posternak.

Suzuki and Yoshimura[1] considered that phytic acid was the hexa-phosphoric acid ester of inosite.

Starkenstein[2] believes that phytin represents a complex pyrophosphoric acid compound with inosite and he proposes the following constitutional formula:



Vorbrodt (loc. cit.) proposes still another formula.

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[1] *Bull. College of Agric.*, Tokyo, 7: 495.
[2] *Biochem. Ztschr.* 30: 56.

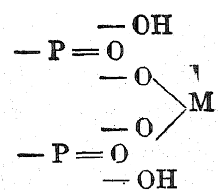
It is impossible at the present time to decide definitely between any of the above constitutional formulas, as the substance has not yet been synthesized in the laboratory.

As represented by the empirical formula, $C_6H_{24}O_{27}P_6$, phytic acid corresponds to a hexa-phosphoric acid ester of inosite plus 3 H_2O.

$$C_6H_6O_6[PO(OH)_2]_6+3H_2O.$$

At present it is impossible to say whether the compound represents a pyrophosphate or if the water is linked in some other way. That the acid contains 12 acid (OH) groups as expressed in the formula of Starkenstein, which would also be the case if it were a hexa-phosphoric acid ester of inosite, and not 18 (OH) groups as in the formula of Neuberg, seems certain, for in no case have we been able to prepare any salt in which more than 12 H-valences were replaced by bases.

As observed by Starkenstein only one half of the 12(OH) groups are particularly reactive. This finds expression in the fact that the barium salt obtained from acid solutions contains only 3 Ba to 6 P. As suggested by the above author, it is probable that these reactive hydroxyls are adjacent but linked to different phosphoric-acid residues. The salts with binary bases would then be represented by the following:



A further confirmation of this is found in the fact that the tri-barium phytate as well as other similar salts of phytic acid with binary bases are strongly acid in reaction.

The presence of only 8 acid (OH) groups, however, can be shown by titrating an aqueous solution of the acid with deci-normal sodium hydroxide using phenolphthalein as indicator. Patten and Hart (loc. cit.) who titrated with deci-normal barium hydroxide using phenolphthalein as indicator obtained results agreeing with a hexa-barium salt.

Of special interest in connection with the constitution of phytin are the phosphoric acid esters of inosite.

Neuberg and Kretschner[1] report obtaining a poly-phosphoric acid ester of inosite by their method of preparing phosphoric acid esters of the carbohydrates and glycerine, that is, by the action of phosphorus oxychloride. The product could, however, not be obtained pure as it was found impossible to separate it from the inorganic phosphates.

[1] *Biochem. Ztschr.* 36: 5.

Contardi[1] claims to have prepared the hexa-phosphoric acid ester of inosite by heating inosite with an excess of phosphoric acid in a stream of carbon dioxide to 160°–165° C. The product was purified as the barium salt and after decomposing the latter with sulphuric acid the free ester was obtained, which he describes as identical with phytic acid. The same author[2] claims to have prepared poly-phosphoric acid esters of mannite, quercite and glucose by the same method.

Carré,[3] however, repeating these experiments, found that the products described by Contardi were merely mixtures of free phosphoric acid and the polyhydric alcohols in question together with their decomposition products mixed with some monobarium phosphate.

Many fruitless efforts have been made in this laboratory to synthesize phytic acid and the hexa-phosphoric acid ester of inosite. All experiments in this direction lead only to the tetra-phosphoric acid ester of inosite, $C_6H_6(OH)_2\ O_4\ [PO(OH)_2]_4$.

The method of Contardi was modified to the extent that inosite, either dry or with water of crystallization, was heated with phosphoric acid, previously dried at 100° to constant weight, in vacuum to a temperature of 140°–160° C. for about two hours.

The same product, viz., the tetraphosphoric ester was obtained whether the phosphoric acid was present in large or small excess above six molecules of H_3PO_4 to one molecule of inosite. When it was present in less quantity than this, however, for instance 1 molecule of inosite to 3 molecules of H_3PO_4, then a mixture of esters was formed. It was found impossible to separate these products completely owing to the fact that they possess about the same solubility.

The tetraphosphoric ester is most conveniently isolated by means of its barium salt. The separation of the ester from the excess of the phosphoric acid or barium phosphate succeeded because its barium salt is much less soluble in dilute alcohol acidified with hydrochloric acid than is barium phosphate.

The new ester is a well characterized compound, very similar in appearance and reactions to phytic acid. By heating with acids, inosite and phosphoric acid are regenerated. It gives a white precipitate with the ordinary molybdate solution, and with excess of silver nitrate a white precipitate is also produced. These reactions are identical with those of phytic acid.

The inosite used in these experiments was prepared from the crude magnesium compound previously mentioned and carefully purified by recrystallization.

The reason why phytic acid could not be obtained by the action of phosphoric acid on inosite is no doubt to be found in that it is not a simple ester but a complex compound as suggested by Starken-

[1] *Atti R. Accad. dei. Lincei*, Roma (5) **19, I:** 23.
[2] *Atti R. Accad. dei. Lincei*, Roma (5) **19, I:** 823.
[3] *Bull. Soc. Chim. France* (4) **9:** 195.

stein. It is, however, difficult to understand why the hexa-phosphoric ester was not obtained by this method. The only explanation that can be offered is that under the conditions of these experiments it is not stable.

One reason alleged by Starkenstein for considering phytin a pyrophosphate is based upon its giving a white precipitate with silver nitrate. This is certainly a characteristic reacton of pyrophosphates. Yet the tetraphosphoric ester gives a pure white precipitate with the same reagent. As the ester cannot be in the form of a pyrophosphate the fact that phytic acid gives the same colored silver compound is not necessarily an indication that it represents a pyrophosphate compound.

The phytic acid used in these experiments was prepared from products obtained from two different sources. The starting material in one case was a calcium phytate imported from Europe; the other was a crude natural magnesium organic-phosphorus compound extracted in this country and kindly supplied us by Dr. Carl S. Miner of Chicago.

As shown by the analyses of the carefully purified salts and of the free acid, these two preparations were identical and they were also identical with the product described as phytic acid by Posternak and other investigators.

EXPERIMENTAL PART.

TRI-BARIUM PHYTATE.

The commercial phytin was purified for analysis by means of the barium salt. 30 gm. calcium phytate was dissolved in a small quantity of 0.5 per ct. hydrochloric acid, diluted to about 2 liters with water and a concentrated solution of 30 gm. barium chloride was added. The precipitate was dissolved without filtering by the addition of just sufficient dilute hydrochloric acid. It was then precipitated by adding barium hydroxide to faintly alkaline reaction. The mixture was then acidified with acetic acid and after standing over night was filtered and well washed in water. It was re-precipitated in the same manner three times. After finally filtering and washing in water the substance was dissolved in about 1 liter of 0.5 per ct. hydrochloric acid, filtered and the filtrate precipitated by adding a like volume of alcohol. After repeating this operation the substance was filtered, washed free of chlorides with 50 per ct. alcohol and finally washed in alcohol and ether and dried in vacuum over sulphuric acid.

The product so obtained was a light, perfectly white semi-crystalline or amorphous powder. Placed on moist litmus paper, it showed a strong acid reaction. It is very slightly soluble in water, slightly soluble in acetic acid and readily soluble in mineral acids.

For analysis the substance was dried at 130° C.

0.2728 gm. substance gave 0.0352 gm. H_2O and 0.0643 gm. CO_2.
0.2763 gm. " " 0.1749 gm. $BaSO_4$ and 0.1675 gm. $Mg_2P_2O_7$.
0.1909 gm. " " 0.1206 gm. $BaSO_4$ and 0.1154 gm. $Mg_2P_2O_7$.

For $C_6H_{12}O_9 [(PO_3H)_2 Ba]_3 = 1120$.
Calculated C 6.42 per ct., H 1.60 per ct., P 16.60 per ct., Ba 36.78 per ct.
Found C 6.42 per ct., H 1.44 per ct., P 16.89 per ct., Ba 37.25 per ct.
P 16.85 per ct., Ba 37.17 per ct.

The barium salt prepared in the same manner from a natural crude magnesium organic phosphorus compound gave the following result on analysis:

0.2057 gm. substance gave 0.0273 gm. H_2O and 0.0480 gm. CO_2
0.1422 gm " " 0.0886 gm. $BaSO_4$ and 0.0841 gm. $Mg_2P_2O_7$.
Found C 6.36 per ct., H 1.48 per ct., P 16.48 per ct., Ba 36.66 per ct.

The two salts are therefore identical.

CRYSTALLIZED TRI-BARIUM PHYTATE.

One gm. purified phytic acid was dissolved in 10 cc. water and 4 gm. of the above mentioned tri-barium phytate added. It was filtered from traces of undissolved particles and allowed to stand for two days at room temperature. The substance had then separated as a heavy crystalline powder of irregular form. From less concentrated solutions the substance separates in small, needle-shaped crystals.

The substance was filtered, washed well in water and finally in alcohol and ether and dried in the air.

For analysis it was dried at 120° C.

0.1972 gm. substance lost 0.0153 gm. H_2O.
0.2028 gm. substance gave 0.1251 gm. $BaSO_4$ and 0.1216 gm. $Mg_2P_2O_7$.
Found P 16.71 per ct., Ba 36.30 per ct.
Calculated for $5H_2O$, 7.44 per ct. Found 7.75 per ct.

PENTA-BARIUM PHYTATE.

This salt is obtained on neutralizing a solution of the tri-barium phytate in 0.5 per ct. hydrochloric acid with barium hydroxide and then acidifying with acetic acid. The precipitate was filtered, washed thoroughly in water, alcohol and ether and dried in vacuum over sulphuric acid.

The product was a white amorphous powder. For analysis the substance was dried at 130° C.

0.2970 gm. substance gave 0.0307 gm. H_2O and 0.0500 gm. CO_2.
0.2507 gm. " " 0.2080 gm. $BaSO_4$ and 0.1207 gm. $Mg_2P_2O_7$.
0.1856 gm. " " 0.1543 gm. $BaSO_4$ and 0.0899 gm. $Mg_2P_2O_7$.

For $C_6H_{14}O_{27}P_6 Ba_5 = 1391$.
Calculated C 5.17 per ct., H 1.00 per ct., P 13.37 per ct., Ba 49.37 per ct.
Found C 4.59 per ct., H 1.15 per ct., P 13.42 per ct., Ba 48.82 per ct.
P 13.50 per ct., Ba 48.92 per ct.

PENTA-BARIUM AMMONIUM PHYTATE.

When the tri-barium phytate is digested in dilute ammonia it is transformed into the penta-barium ammonium salt and ammonium

phytate. The latter product, however, was found to contain some barium.

Two gm. of the analyzed tri-barium phytate was digested for two hours in 25 cc. of 2.5 per ct. ammonia, filtered and washed in dilute ammonia and finally in alcohol and dried in vacuum over sulphuric acid. The product was a heavy white amorphous powder. On moist litmus paper it showed a neutral reaction.

For analysis the substance was dried at 130° C.

0.1509 gm. substance gave 0.1205 gm. $BaSO_4$ and 0.0762 gm. $Mg_2P_2O_7$.
0.1747 gm. " " 0.0026 gm. N (Kjeldahl*)

For $C_6H_{12}O_{27}P_6Ba_5\ (NH_4)_2 = 1425$.

Calculated P 13.05 per ct., Ba 48.19 per ct., N 1.96 per ct.
Found P 14.07 per ct., Ba 46.99 per ct., N 1.48 per ct.

By evaporating the filtrate from the above to dryness on the water-bath an amber-colored mass remained which after drying at 130° C. gave the following result on analysis:

Found P 20.51 per ct., Ba 6.65 per ct., N 10.48 per ct.

PENTA-MAGNESIUM AMMONIUM PHYTATE.

Two gm. phytic acid was dissolved in 400 cc. water and then precipitated by adding excess of magnesia mixture slowly and under constant shaking. After the precipitate had settled the supernatant liquid was decanted, the residue filtered and washed with water until free from chlorides and finally washed in alcohol and ether and dried in vacuum over sulphuric acid.

The product was a fine white amorphous powder and weighed 2.7 gm. It reacts neutral on moist litmus paper.

For analysis it was dried at 130°.

0.1089 gm. substance gave 0.0832 gm. $Mg_2P_2O_7$ for P.
0.1089 gm. " " 0.0705 gm. $Mg_2P_2O_7$ for Mg.
0.1248 gm. " " 0.0039 gm. N
0.0893 gm. " " 0.0028 gm. N } Kjeldahl)

For $C_6H_{12}O_{27}P_6Mg_5(NH_4)_2 = 859.5$.

Found P 21.29 per ct., Mg 14.13 per ct., N 3.12 per ct.—3.13 per ct.
Calculated P 21.64 per ct., Mg 14.13 per ct., N 3.25 per ct.

If the phytic acid is first neutralized with ammonia and then precipitated with magnesia mixture the same product is obtained.

Two gm. phytic acid in 400 cc. water was neutralized with ammonia, precipitated with excess of magnesia mixture, filtered, washed free of chlorides with dilute ammonia and then in alcohol and dried in vacuum over sulphuric acid.

For analysis the substance was dried at 130° C.

Found P 21.49 per ct., Mg 13.96 per ct., N 3.47 per ct., 3.48 per ct.

TETRA-CUPRIC DI-CALCIUM PHYTATE.

To a solution of 2 gm. phytic acid in 200 cc. water excess of calcium chloride was added and the solution then neutralized with ammonia.

* This and subsequent nitrogen determinations were made by Mr. M. P. Sweeney.

The precipitate was just dissolved in dilute hydrochloric acid and the solution precipitated with copper acetate. The bluish-green colored copper-compound was filtered off, washed with water until free from chlorides and then in alcohol and dried in vacuum over sulphuric acid.

The dry substance was a light blue amorphous powder. It is very slightly soluble in water or in very dilute acids, readily soluble in the ordinary dilute mineral acids. It is readily soluble in 2.5 per ct. ammonia with a deep blue color. In this solution concentrated ammonia or alcohol produces a light-blue colored precipitate.

The compound represents a nearly pure tetra-cupric di-calcium phytate. It contained 0.17 per ct. N.

For $C_6H_{12}O_9(PO_3Cu)_4 \cdot (PO_3Ca)_2 = 1036$.

Calculated Cu 24.51 per ct., Ca 7.72 per ct., P 17.95 per ct.
Found Cu 25.58 per ct., Ca 7.69 per ct., P 16.85 per ct.

If a slightly acid solution of magnesium ammonium phytate is precipitated with copper acetate a light blue colored copper compound is obtained. After washing and drying it gave the following result on analysis:

Mg 1.11 per ct., Cu 34.27 per ct., N 0.64 per ct., and 0.52 per ct., P 15.66 per ct.

This compound is exceedingly soluble in dilute and concentrated ammonia. By the careful addition of alcohol to the ammoniacal solution a substance separates in light blue colored crystals on standing. This is evidently a complex copper-ammonium salt but it was not further examined.

PHYTIC ACID.

This was prepared after the method of Patten and Hart (loc. cit.). The analyzed tri-barium salt was decomposed with the calculated quantity of deci-normal sulphuric acid. After removing the barium sulphate, the solution was precipitated with copper acetate. The copper compound was decomposed with hydrogen sulphide, the copper sulphide filtered off, the filtrate concentrated in vacuum and finally dried in vacuum over sulphuric acid. The products obtained from both the calcium phytate and the magnesium compound were light amber-colored, very thick liquids and corresponded in all respects with the body described by other investigators as phytic acid.

For analysis the substance was dried at 130° C.

a. From calcium phytate.

0.3193 gm. substance gave 0.0917 gm. H_2O and 0.1238 gm. CO_2.
0.1505 gm. " " 0.1424 gm. $Mg_2P_2O_7$.

b. From the magnesium compound.

0.2789 gm. substance gave 0.0804 gm. H_2O and 0.1101 gm. CO_2.
0.1236 gm. " " 0.1160 gm. $Mg_2P_2O_7$.

For $C_6H_{24}O_{27}P_6 = 714$.

Calculated.	Found a.	Found b.
C 10.08 per ct.	10.57 per ct.	10.76 per ct.
H 3.36 "	3.21 "	3.22 "
P 26.05 "	26.37 "	26.16 "

Titrated against deci-normal sodium hydroxide using phenolphthalein as indicator the following results were obtained:

0.2648 gm. acid required 30.7 cc. N/10 NaOH.
Calculated for 8 NaOH 29.65 cc.

0.1593 gm. acid required 18.60 cc. N/10 NaOH.
Calculated for 8 NaOH 17.60 cc.

INOSITE FROM THE CRUDE MAGNESIUM COMPOUND.

Twenty-five gms. of the air-dried substance, containing 20 per ct. of moisture, was heated with 100 cc. 30 per ct. sulphuric acid in a sealed tube for about three hours at a temperature of 140° C. Two tubes equally charged were heated at the same time. After cooling, the reaction mixture was of dark brown color and a considerable quantity of magnesium salts had crystallized out.

The contents were washed into a beaker, filtered and diluted with water to about 1500 cc. The sulphuric and phosphoric acids and the magnesium were then precipitated by barium hydroxide, filtered and well washed in hot water. The filtrate was evaporated to about 350 cc. and the excess of barium removed by carbon dioxide, filtered, the filtrate decolorized with animal charcoal and then evaporated on the water bath to a syrupy consistency. This was taken up in a small quantity of hot water, filtered and alcohol added to the filtrate until a cloudiness was produced. By scratching with a glass rod crystallization began; more alcohol was then added and the mixture placed in the ice-chest over night. After filtering and washing in alcohol and ether and drying in the air the product weighed from 5.1 to 5.4 gm. From the mother liquor a further quantity of crystals from 0.4 to 0.6 gm. could be obtained on the addition of ether and allowing to stand for twenty-four hours in the cold.

For purification the raw product was dissolved in 6 parts of water and again brought to crystallization by the addition of alcohol as before. It was then obtained in large, thin, colorless plates.

It gave the reaction of Scherer. The dried substance melted at 220° C. (uncor.)

Dried at 100° C. 0.4136 gm. substance lost 0.0669 gm. H_2O and 0.1600 gm. lost 0.0258 gm. H_2O.

The dried substance was analyzed.

0.1342 gm. substance gave 0.0791 gm. H_2O and 0.1981 gm. CO_2.

For $C_6H_6(OH)_6 = 180$.

Calculated C 40.00 per ct., H 6.66 per ct., 2 H_2O 16.66 per ct.
Found C 40.26 per ct., H 6. 59 per ct., 2 H_2O 16.17 per ct. – 16.12 per ct.

This substance was used in subsequent experiments with phosphoric acid. Some 40 gm. of inosite were prepared in this way.

TETRA-PHOSPHORIC ACID ESTER OF INOSITE.

4.32 gm. (2 mol.) crystallized inosite was powdered and mixed in a distillation flask with 24 gm. phosphoric acid (about 24 mol. or double the quantity required to form the hexa-phosphoric ester). The acid had been previously dried at 100° C. to constant weight. The flask was connected with the vacuum pump and heated in an oil bath to 140°–160° C. for about two hours. By 120° water began to come over and the reaction was practically complete at the end of one hour. After cooling, the reaction mixture was a thick, reddish-brown colored, nearly solid mass. This was dissolved in about 1 liter of water and a solution of 40 gms. of barium chloride in 400 cc. of water was added. The barium salt of the ester was then precipitated by the addition of about 1 liter of alcohol.

A solution containing phosphoric acid and barium chloride in the same dilution as above remains perfectly soluble on the addition of a like volume of alcohol.

The voluminous flaky precipitate was filtered off at once and thoroughly washed in 33⅓ per ct. alcohol.

For purification the substance was dissolved in 700 cc. of 0.5 per ct. hydrochloric acid, filtered from slight insoluble residue, the filtrate diluted with 500 cc. of water, some barium chloride added and then precipitated by the addition of a like volume of alcohol. This was repeated a second time. The substance was then dissolved in 500 cc. of 0.5 per ct. hydrochloric acid, precipitated by adding barium hydroxide to slightly alkaline reaction, then acidifying with hydrochloric acid and adding 500 cc. alcohol. After filtering and washing as before the substance was again twice precipitated from 0.5 per ct. hydrochloric-acid solution with alcohol and finally washed in 50 per ct. alcohol, alcohol and ether and dried in vacuum over sulphuric acid. The product weighed 8.9 gm. It was a white voluminous amorphous powder. On moist litmus paper it showed a strong acid reaction. The solubility of the product was practically the same as for the tri-barium phytate.

For analysis it was dried at 100° and 130° C.

0.3252 gm. substance lost 0.0281 gm. H_2O.

0.2697 gm. substance gave	0.0442 gm. H_2O	and	0.0878 gm. CO_2.
0.2038 gm. " "	0.0300 gm. H_2O	"	0.0685 gm. CO_2.
0.2482 gm. " "	0.1505 gm. $BaSO_4$	"	0.1434 gm. $Mg_2P_2O_7$.
0.1833 gm. " "	0.1108 gm. $BaSO_4$	"	0.1075 gm. $Mg_2P_2O_7$.
0.1776 gm. " "	0.1074 gm. $BaSO_4$	"	0.1038 gm. $Mg_2P_2O_7$.

For $C_6H_6(OH)_2O_4\,[(PO_3H)_2Ba]_2 = 770.7$.

Calcul'd C 9.34 per ct., H 1.55 per ct., P 16.08 per ct., Ba 35.64 per ct.
Found C 8.87 per ct., H 1.83 per ct., P 16.10 per ct., Ba 35.68 per ct.
C 9.16 per ct., H 1.64 per ct., P 16.34 per ct., Ba 35.57 per ct.
P 16.29 per ct., Ba 35.58 per ct.

Calculated for 4 H_2O, 8.55 per ct. Found 8.64 per ct.

Another lot prepared by heating 1.80 gm. dry inosite (1 mol.) with 7.9 gm. dry phosphoric acid (about 8 mol.) and isolated in the same manner gave the following results on analysis:

0.2879 gm. substance lost 0.0240 gm. H_2O.

The dried substance was analyzed.

0.2639 gm. substance gave 0.0452 gm. H_2O and 0.0936 gm. CO_2.
0.1480 gm. " " 0.0866 gm. $BaSO_4$ " 0.0846 gm. $Mg_2P_2O_7$.
0.1632 gm. " " 0.0959 gm. $BaSO_4$ " 0.0933 gm. $Mg_2P_2O_7$.

Found C 9.67 per ct., H 1.91 per ct., P 15.93 per ct., Ba 34.43 per ct.
H_2O 8.33 per ct., P 15.93 per ct., Ba 34.58 per ct.

A third lot prepared by heating 1.80 gm. dry inosite (1 mol.) with 5.88 gm. dry phosphoric acid (6 mol.) and isolating in the same manner as before gave the following:
C 9.69 per ct., H 1.75 per ct., P 16.06 per ct., Ba 36.33 per ct.

It is apparent therefore that in each of the above experiments the same compound was produced.

THE FREE TETRA-PHOSPHORIC ESTER.

About 5 gm. of the purified barium salt was decomposed by digesting it with the calculated quantity of deci-normal sulphuric acid. After removing the barium sulphate the solution was precipitated with excess of copper acetate. The copper precipitate was filtered, thoroughly washed with water, suspended in water and decomposed with hydrogen sulphide. The copper sulphide was removed by filtration, the filtrate concentrated in vacuum and finally dried in vacuum over sulphuric acid until it was of a thick, syrupy consistency.

For analysis the substance was dried at 130° C.

0.3020 gm. substance gave 0.0933 gm. H_2O and 0.1577 gm. CO_2.
0.1605 gm. " " 0.1387 gm. $Mg_2P_2O_7$.

For $C_6H_6(OH)_2O_4[PO(OH)_2]_4 = 500$.

Calculated C 14.40 per ct., H 3.20 per ct., P 24.80 per ct.
Found C 14.24 per ct., H 3.45 per ct., P 24.09 per ct.

0.1663 gm. substance required 16.5 cc. deci-normal sodium hydroxide using phenolphthalein as indicator. This corresponds to 5 acid (OH) groups.

Calculated for 5 NaOH 16.63 cc.

PROPERTIES OF THE FREE ESTER.

The concentrated aqueous solution of the ester is very similar to phytic acid. It is a very thick, light, amber-colored liquid of sharp acid, slightly astringent taste and strong acid reaction. On longer keeping in the desicator over sulphuric acid it becomes hard and brittle and may be powdered. It is then very hygroscopic.

The dry substance is slowly but completely soluble in alcohol, readily soluble in water.

The concentrated aqueous solution gives a white precipitate with silver nitrate in excess which dissolves on largely diluting with water. The precipitate is readily soluble in ammonia, dilute nitric, sulphuric and acetic acids, insoluble in glacial acetic acid.

With ferric chloride it gives a white or faintly yellowish precipitate which is very sparingly soluble in acids.

With lead acetate a white precipitate is produced, readily soluble in dilute nitric acid, but sparingly soluble in acetic acid.

With barium chloride it gives a white precipitate slightly soluble in acetic acid, but readily soluble in hydrochloric and nitric acids.

Calcium chloride does not give a precipitate, but, on heating, the calcium salt is thrown down as a white precipitate which redissolves on cooling.

Magnesium salts do not cause a precipitate, and on heating the solution merely turns cloudy; on cooling it clears up again.

With the ordinary molybdate solution it gives in the cold a white voluminous flaky precipitate which slowly turns yellowish in color. Phytic acid under the same conditions gives a white precipitate which remains unchanged in the cold. On drying at 110° or 130° the substance turns very dark in color.

The ester, like phytic acid, fails to give directly the Scherer reaction for inosite.

INOSITE FROM THE TETRA-PHOSPHORIC ESTER.

Ten gm. of the purified barium salt was heated with 25 cc. 30 per ct. sulphuric acid in a sealed tube to about 150° C. for three hours. After precipitating the sulphuric and phosphoric acids with barium hydroxide the inosite was isolated by the usual method and recrystallized from hot dilute alcohol. It was filtered and washed in alcohol and ether and dried in the air. Yield 1.52 gm. It was obtained in the form of small colorless six-sided plates, free from water or crystallization. The air-dried, water-free substance melted at 221° C., uncor.

0.2094 gm. substance gave 0.1259 gm. H_2O and 0.3033 gm. CO_2.
0.1360 gm. " " 0.0827 gm. H_2O " 0.1991 gm. CO_2.

For $C_6H_{12}O_6$ = 180.

Calculated	C 40.00 per ct.,	H 6.66 per ct.
Found	C 39.50 per ct.,	H 6.72 per ct.
	C 39.93 per ct.,	H 6.80 per ct.

As already mentioned, if a mixture of inosite and phosphoric acid is heated when less than 6 mol. H_3PO_4 are present to 1 mol. inosite, a mixture of esters is obtained. It was found impossible to separate these bodies as barium salts and obtain pure compounds, since their solubilities are apparently nearly alike.

3.60 gm. dry inosite (2 mol.) and 5.88 gm. dry phosphoric acid (6 mol.) were heated in a distillation flask as before to 180°–190° for

about two hours, until water ceased coming over. The reaction mixture was in form of a very bulky, thin flaky mass, very brittle and of yellowish-brown color, mixed with some very dark-colored substance. It was broken up with a glass rod and removed from the flask and treated with water, in which the dark-colored portion was readily soluble, but the lighter-colored substance was insoluble in this medium. It was powdered in a mortar and thoroughly washed in water and alcohol and dried in vacuum over sulphuric acid.

The substance was apparently insoluble in boiling water, in boiling dilute acids and in glacial acetic acid; also insoluble in alcohol, ether and other organic solvents. After drying at 130° the substance was analyzed.

0.2500 gm. substance gave 0.0838 gm. H_2O and 0.2085 gm. CO_2.
0.1500 gm. " " 0.1145 gm. $Mg_2P_2O_7$.
0.1542 gm. " " 0.1178 gm. $Mg_2P_2O_7$.

Found C 22.74 per ct., H 3.75 per ct., P 21.28 per ct., 21.29 per ct.

This agrees approximately with a mono-pyro-phosphoric ester of inosite, but the phosphorus is too high.

It was decided to purify it by means of the barium salt. The substance was dissolved by boiling in dilute sodium hydroxide, in which it gave a dark amber-colored solution. After filtering it was precipitated with barium chloride; the barium precipitate filtered and washed free of alkali. It was then dissolved in 500 cc. 0.5 per ct. hydrochloric acid and precipitated by barium hydroxide. After filtering and washing it was repeatedly precipitated with alcohol from 0.5 per ct. hydrochloric-acid solution until finally a small amount of a white amorphous powder was obtained. After drying at 130° this was analyzed.

0.2028 gm. substance gave 0.0412 gm. H_2O and 0.0979 gm. CO_2.
0.2207 gm. " " 0.0413 gm. H_2O " 0.1042 gm. CO_2.
0.1982 gm. " " 0.0996 gm. $BaSO_4$ " 0.1103 gm. $Mg_2P_2O_7$.

Found C 13.16 per ct., H 2.27 per ct., P 15.51 per ct., Ba 29.57 per ct.
C 12.88 per ct., H 2.09 per ct.

In this compound the relation between the carbon and phosphorus is nearly 6 C to 3 P, which would indicate a tri-phosphoric ester. The substance was, however, far from pure, and lack of material prevented any further investigation of this body, which is apparently a mixture of various esters.

PHYTIN AND PYROPHOSPHORIC ACID ESTERS OF INOSITE. II.*

R. J. ANDERSON.

SUMMARY.

Several new salts of phytic acid are described, viz.: The calcium-magnesium-potassium phytate, the penta-calcium phytate, the tetra-calcium phytate, the penta-magnesium phytate, the copper salts obtained when precipitating phytic acid with copper acetate, the octa-silver phytate and the hepta-silver phytate.

Efforts to synthesize phytic acid by acting on dry inosite with dry pyrophosphoric acid lead to the formation of esters.

Two of these, viz., the di-pyrophosphoric acid ester of inosite and a di-inosite tri-pyrophosphoric acid ester were obtained in pure form and analyzed.

These esters are very similar to phytic acid in appearance, taste and reactions. They yield similar acid salts and on hydrolysis inosite and phosphoric acid are produced.

INTRODUCTION.

In the last report[1] from this laboratory on the chemistry of phytin, various salts of phytic acid were described, as well as the tetra-phosphoric acid ester of inosite. Since then the investigation has been continued in connection with another problem dealing with the form in which phytin exists in wheat bran, which is not yet finished, but as the present work is closely related to that reported earlier, it seems advisable to publish it at this time.

In addition to the salts of phytic acid described before, the following have been prepared:

The calcium-magnesium-potassium phytate, $C_6H_{12}O_{27}P_6Ca_3Mg_2K_2$, a white amorphous powder obtained by neutralizing a solution of calcium-magnesium phytate in dilute hydrochloric acid with potassium hydroxide.

The penta-calcium phytate, $C_6H_{14}O_{27}P_6Ca_5$, is obtained as a white powder on precipitating an aqueous solution of phytic acid with calcium acetate.

The tetra-calcium phytate, $C_6H_{16}O_{27}P_6Ca_4 + 12H_2O$ is obtained as a white, semi-crystalline or fine granular powder when the above penta-calcium phytate in dilute hydrochloric acid solution is evaporated in vacuum in the presence of calcium acetate.

The penta-magnesium phytate, $C_6H_{14}O_{27}P_6Mg_5 + 24H_2O$, is obtained as crystalline powder when an aqueous solution of phytic acid and excess of magnesium acetate is evaporated in vacuum.

A copper salt corresponding to a hexacupric phytate, $C_6H_{12}O_{27}P_6Cu_6$, is obtained when phytic acid is precipitated with copper acetate.

[1] *Jour. Biological Chem.* 11: 471, (1912); and Tech. Bul. No. 19 of this Station.

* A reprint of Technical Bulletin No. 21, June, 1912.

The octa-silver phytate, $C_6H_{16}O_{27}P_6Ag_8$, is precipitated as a white amorphous powder by alcohol from an aqueous solution of phytic acid containing twelve equivalents of silver nitrate.

The hepta-silver phytate, $C_6H_{17}O_{27}P_6Ag_7$, results when the dilute nitric-acid solution of the above octa-silver phytate is precipitated with alcohol.

Since various attempts to synthesize phytic acid or to prepare a hexa-phosphoric acid ester of inosite by acting on inosite with phosphoric acid only lead to the formation of the tetra-phosphoric acid ester of inosite [1] it seemed of interest to determine what products would be formed when acting on inosite with pyrophosphoric acid. If phytin were a complex pyrophosphoric acid compound of inosite as suggested by Starkenstein [2] it appeared not impossible to synthesize it from these constituents. Such a synthesis would be of considerable theoretical and scientific value in connection with the chemistry of phytin and would also furnish an additional proof of the presence of pyrophosphoric acid compounds in nature.

Several futile efforts were made in this direction but it was found that the reactions tried only lead to pyrophosphoric acid esters of inosite. These esters are very easily formed but their purification is very difficult.

When acting on dry inosite (1 mol.) with dry pyrophosphoric acid (3 mol. or sufficient to form phytic acid) at a temperature of 200°-220° a new and stable ester is formed. On analysis, results were obtained corresponding to a di-pyrophosphoric acid ester of inosite, a compound isomeric with the tetra-phosphoric acid ester described in a former paper.

Attempts to isolate the reaction product by the method described for the tetra-phosphoric ester, [3] that is, by precipitating as a barium salt with alcohol, in the presence of hydrochloric acid, failed at first because barium pyrophosphate is equally insoluble in acidified dilute alcohol as barium phytate, for instance, or the pyrophosphoric acid esters. Various other salts were tried with negative results; the pyrophosphate invariably would be precipitated at the same time.

As is well known, pyrophosphoric acid when boiled with dilute mineral acids is very easily transformed into orthophosphoric acid. The isolation of the new ester was made possible by taking advantage of this property

In the last paper [4] it was reported that phytin, when dry and free from mineral acids, is stable; that drying at 115° C. caused no appreciable decomposition and that no inosite could be isolated from 100 gms. of phytin after drying to constant weight at this temperature.

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[1] Anderson, *loc. cit.*
[2] *Biochem. Ztschr.* 30: 56.
[3] Anderson, *loc. cit.*
[4] Ibid. *loc. cit.*

Experience since then has shown that phytin may be boiled for hours in dilute hydrochloric or sulphuric acid without suffering marked decomposition. In fact it may be boiled for days with 30 per ct. sulphuric acid without a determinable quantity of inosite being formed. This seemed strange as various other investigators have emphasized the fact that phytin is very easily hydrolyzed and that even in water it suffers a more or less rapid decomposition.

The action of nitric acid seems to cause a more rapid decomposition; for even the purest phytin when *warmed* in dilute nitric acid solution with ammonium molybdate gives very quickly the characteristic yellow precipitate of ammonium-phosphomolybdate. Several days, however, are required to cause complete decomposition in dilute nitric acid solution at a temperature of 60°–70° C. Quantitative experiments to measure the rate of decomposition have not been carried out, but it could very easily be done as the change is very slow.

The following will illustrate this point:

In an analysis of two different phytin preparations the substance was boiled with concentrated nitric acid under occasional additions of concentrated hydrochloric acid for about half an hour. At the end of this time the organic matter was apparently destroyed, as the solution was practically colorless. The phosphorus was determined in this solution by the usual molybdate method. After keeping at a temperature of 60° C. for one hour the precipitate was filtered off and the filtrate again warmed on the water-bath for another hour. A new portion of the yellow precipitate had then formed which was removed by filtration and the filtrate again warmed on the water-bath. A yellow precipitate continued to form slowly but continuously for two days when the experiment was discontinued. During this time the water lost by evaporation was replaced from time to time and small quantities of nitric acid were also added. The phosphorus determined in the first precipitate and in that which formed during the first day amounted to only 9.92 and 10.25 per ct., whereas when determined after first destroying the organic matter by the Neumann method 14.42 and 15.23 per ct. respectively were found.

In another case 100 gm. of calcium phytate was boiled under a reflux condenser with about 300 cc. of 30 per ct. sulphuric acid continuously for one day; over night it was heated on the water-bath and the next day the boiling was continued all day. After precipitating with excess of barium hydroxide, thorough washing in hot water, removal of excess of barium by carbon dioxide and evaporating on the water-bath, no inosite could be found in the slight residue which remained.

To determine if the phytin molecule suffered any partial decomposition on boiling with dilute acids, 1 gm. of phytic acid, dissolved

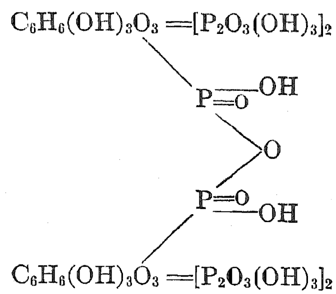
in 100 cc. of water acidified with 10 cc. 5/N hydrochloric acid, was boiled over a free flame for one hour. After cooling, barium chloride was added and the barium phytate precipitated by the addition of alcohol. The substance was twice purified by precipitating its hydrochloric acid solution with alcohol. On analysis, results were obtained which showed that the substance was a pure tri-barium phytate, the salt which is always obtained under the above conditions of precipitation.

In view of this relative stability of the phytin molecule it was thought that the pyrophosphoric acid ester referred to above might be more stable than the pyrophosphoric acid in the reaction mixture. Qualitative experiments showed that this was actually the case.

An aqueous solution of pyrophosphoric acid, acidified with hydrochloric acid and a solution of the above inosite-pyrophosphoric acid reaction-mixture, also acidified with hydrochloric acid, were boiled for one hour. Some barium chloride and a like volume of alcohol were then added. The solution containing only pyrophosphoric acid gave no precipitate, while, before boiling, alcohol produced at once a white precipitate of barium pyrophosphate. The solution containing the inosite-pyrophosphoric acid reaction mixture gave a white flocculent precipitate, the barium salt of the new ester.

As the excess of the pyrophosphoric acid was present as orthophosphoric acid after boiling it did not interfere with the purification of the compound by the dilute acid alcohol method.

By acting on dry inosite (one mol.) with dry pyrophosphoric acid (six mol.) at a temperature of 200°–220° C., another new pyrophosphoric ester was obtained. After boiling, as before, with dilute hydrochloric acid and purifying as the barium salt this product was found to be a di-inosite tri-pyrophosphoric acid ester; that is, its molecule was evidently made up of two molecules of dipyrophosphoric acid esters of inosite joined through one molecule of pyrophosphoric acid and, accordingly, it corresponds with the following formula:



It is evident therefore that complex compounds such as phytic acid is supposed to be cannot be formed at elevated temperatures,

as in the various reactions tried in these experiments only esters were produced, and at lower temperatures apparently no reaction takes place. These compounds are in physical and chemical properties very similar to phytic acid. They form analogous acid salts which in appearance and solubility seem almost identical with salts of phytic acid. Whether esters, such as above, are found in nature is at present unknown. It is, however, not impossible that a part of the organically bound phosphorus existing in plants may be present in some such, or similar, forms.

The silver salts previously referred to were prepared in the hope that they might serve for the preparation of an ester of phytic acid with which molecular weight determinations might be made. As was to be expected, however, only acid salts were obtained and, as such, were quite useless for the purpose in view. In the reaction between phytic acid and silver nitrate, nitric acid is of course liberated and when any strong acid is present only acid phytates are obtained.

Efforts made to prepare an ester by acting on sodium phytate with methylsulphate proved useless as no ester could be isolated. Further experiments along this line are contemplated and will be reported later.

In an article concerning the phosphorus compounds found in food materials which appeared in a Swedish chemical journal little known in this country and which is not abstracted by any of the larger chemical journals, a valuable contribution to the chemistry of phytin was made by A. Rising.[1] Among other things he describes a silver phytate of the following composition: C 5.5, H 1.08, P 13.2 and Ag 52.65 per ct., from which results he concludes that it must represent a complex pyrophosphoric acid compound of inosite. It is noteworthy that this author and E. Starkenstein,[2] independently, and practically at the same time expressed the same opinion, viz: that phytin represents a complex pyrophosphoric acid compound of inosite.

The silver salt described by Rising corresponds to the hepta-silver phytate mentioned in this paper. He proposes the following empirical formula: $C_6H_{14}Ag_6P_5O_{22}$, but his results agree equally well with a hepta-silver phytate: $C_6H_{17}O_{27}P_6Ag_7$.

	Calculated	Found by Rising	Found for hepta-silver phytate in this laboratory
C	4.92........	5.50	
H	1.16........	1.08	
P	12.72........	13.20	13.02 per cent.
Ag	51.64........	52.65	52.43 per cent.

From the above there appears to be no doubt that these salts are identical.

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[1] *Svensk Kemisk Tidskrift* 22: 143 (1910).

Note.— I am indebted to Mr. A. R. Rose of Columbia University for this as well as for many other valuable references to literature.

[2] *Loc. cit.*

The several salts of phytic acid reported in this paper were prepared from previously purified and analyzed phytic acid and for this reason it was deemed quite superfluous to make carbon and hydrogen determinations on each salt.

EXPERIMENTAL.

CALCIUM MAGNESIUM POTASSIUM PHYTATE.

Two gms. phytic acid was dissolved in about 100 cc. of water, 0.224 gm. of MgO (2 mol.), and 0.84 gm. $CaCO_3$ (3 mol.) added. The MgO dissolved at once and nearly all the calcium carbonate but the salt of phytic acid was precipitated at the same time as a white precipitate. This was dissolved by a few drops of hydrochloric acid, the solution filtered and the filtrate rendered slightly alkaline to litmus with potassium hydroxide. After the precipitate has settled it was filtered off, washed well in 50 per ct. alcohol, alcohol and ether and dried in vacuum over sulphuric acid. The product was a fine white amorphous powder. It was free from chlorine. On moist litmus paper it showed a faintly alkaline reaction. It was slightly soluble in water but readily soluble in dilute acids. Yield 2.9 gm.

After drying at 105° in vacuum over phosphorus pentoxide it was analyzed.

For $C_6H_{12}O_{27}P_6\ Ca_3Mg_2\ K_2 = 948$
Calculated Ca 12.65; Mg 5.12, K 8.24, P 19.60 per ct.
Found Ca 13.03; Mg 4.29, K 6.42, P 19.07 per ct.

This shows the difficulty of obtaining pure salts of phytic acid when several bases are combined in the same molecule of the salt.

PENTA-CALCIUM PHYTATE.

One gm. phytic acid was dissolved in about 50 cc. of water and excess of calcium acetate added. On the first addition of the calcium acetate a white precipitate is produced, but on shaking this redissolves and only after a liberal excess of the acetate has been added is the precipitate permanent. After settling, the product was filtered and thoroughly washed in 50 per ct. alcohol, alcohol and ether and dried in vacuum over sulphuric acid. The substance was a perfectly white amorphous powder. On moist litmus paper it showed an acid reaction. It is only slightly soluble in water, readily soluble in dilute mineral acids, less soluble in acetic acid.

For analysis it was dried at 105° in vacuum over phosphorus pentoxide.

For $C_6H_{14}O_{27}P_6Ca_5 = 904$
Calculated Ca 22.12: P 20.57 per ct.
Found Ca 22.46: P 20.62 per ct.

TETRA-CALCIUM PHYTATE.

Various attempts were made to obtain a penta-calcium phytate in crystalline form without success. A tetra-calcium phytate was finally obtained by the following method:

The penta-calcium phytate was dissolved in a small quantity of 0.5 per ct. hydrochloric acid, a concentrated solution of calcium acetate was added until a permanent precipitate remained which was then dissolved by the addition of a few drops of dilute hydrochloric acid. On now concentrating in vacuum to somewhat less than half the bulk at a temperature of 40° the calcium salt separates. The product was filtered off, washed thoroughly in 50 per ct. alcohol, alcohol and ether and dried in the air. The substance was a white semicrystalline or fine granular powder of irregular form. Its solubility was practically the same as for the penta-calcium phytate. It was free from chlorine.

On drying at 105° in vacuum over phosphorus pentoxide the substance lost water corresponding to 12 H_2O.

0.2120 gm. subst.: 0.0422 gm. H_2O.
0.1238 gm. subst. gave 0.0308 gm. CaO and 0.0967 gm. $Mg_2P_2O_7$.
0.1857 gm. subst. gave 0.0456 gm. CaO and 0.1448 gm. $Mg_2P_2O_7$.

For $C_6H_{16}O_{27}P_6Ca_4 = 866$

Calculated	Ca 18.47:	P 21.47 per ct.
Found	Ca 17.78:	P 21.77 per ct.
	Ca 17.55:	P 21.73 per ct.

For 12 H_2O calculated 19.96: found 19.90 per ct.

PENTA-MAGNESIUM PHYTATE.

After dissolving 2.5 gm. phytic acid in about 100 cc. of water, a concentrated solution of magnesium acetate was added. This did not cause any precipitate nor could the substance be brought to crystallization by any of the usual methods. The solution was then concentrated to about half its bulk in vacuum at a temperature of 35°–40°. As the concentration proceeded the substance began to separate as a heavy powder. This was filtered off, well washed in dilute alcohol, alcohol and ether and dried in the air. The product was a perfectly white semi-crystalline or loose granular powder of irregular form. On moist litmus paper it showed an acid reaction. It was slightly soluble in water, readily soluble in acids.

For analysis it was dried at 105° in vacuum over phosphorus pentoxide. It lost water corresponding to 24 H_2O.

0.1504 gm. subst. gave 0.0510 gm. H_2O.
0.0997 gm. subst. gave 0.0671 gm. $Mg_2P_2O_7$ for Mg.
0.0498 gm. subst. gave 0.0393 gm. $Mg_2P_2O_7$ for P.

For $C_6H_{14}O_{27}P_6Mg_5 = 825.5$
Calculated Mg 14.71: P 22.53 per ct.
Found Mg 14.69: P 21.99 per ct.
For 24 H_2O Calculated 34.36: found 33.91 per cent.

HEXA–CUPRIC PHYTATE.

This salt is precipitated directly from phytic acid solutions by copper acetate. It is difficult, however, to obtain a pure compound as it is apt to contain either too little or too much copper, depending upon the conditions under which the precipitate is formed. In the purification of phytic acid it is usual to remove other bases which are present by repeatedly precipitating with barium chloride; the barium salt which is finally obtained is then decomposed with sulphuric acid. It is found, however, that if only the calculated quantity of sulphuric acid is used the barium sulphate which is formed is in an extremely fine condition which it is impossible to remove completely either by repeated filtrations or even by day-long centrifuging. But if a slight excess of sulphuric acid is used the barium sulphate in the course of only a few hours becomes heavy and granular and may be easily removed by simple filtration. In order to get rid of the excess of sulphuric acid the solution is now precipitated with copper acetate. The copper salt can be easily washed free of the sulphate and acetate with water as it is very slightly soluble in very dilute acids. The pure copper salt is then easily decomposed with hydrogen sulphide and the free phytic acid obtained.

The copper phytate obtained from such slightly acid solutions was analyzed and the following results obtained:

For $C_6H_{12}O_{27}P_6Cu_6 = 1083$
Calculated Cu 35.18: P 17.17 per ct
Found Cu 33.54: P 16.88 per ct.

Pure phytic acid in water was precipitated with pure copper acetate when a compound was obtained which had the following composition:

Cu 37.57: P 15.13 per ct.

It is seen from above that from slightly acid solutions of phytic acid a copper salt is precipitated which contains somewhat too little copper while from an aqueous phytic acid solution a salt is obtained which contains over 2 per ct. excess of copper.

The copper phytate is, like all other phytates, exceedingly soluble in 10 per ct. phytic acid. It dissolves readily until a thick heavy syrup is formed, but it was found impossible to bring this solution to crystallization. Both of the above copper salts show an acid

reaction on moist litmus paper. The red color is only developed slowly and is probably due to hydrolysis.

OCTA-SILVER PHYTATE.

This salt is obtained when an equeous solution of phytic acid, mixed with twelve equivalents of silver nitrate, is precipitated with alcohol. The product is a heavy, white, flocculent precipitate which settles at once. It was filtered off, washed in dilute alcohol, alcohol and ether and dried in vacuum over sulphuric acid. The product is only slightly affected by light but on continued exposure turns first yellowish and later dark in color. In the dry state it is a heavy white amorphous powder of acid reaction on moist litmus paper. It is very soluble in dilute nitric acid and exceedingly soluble in phytic acid. Many attempts were made to bring it to crystallization from the latter solution without success.

For analysis it was dried at 105° in vacuum over phosphorus pentoxide.

For $C_6H_{16}O_{27}P_6Ag_8 = 1569$
Calculated Ag 55.00; P 11.85 per ct.
Found Ag 55.98: P 11.94 per ct.

HEPTA-SILVER PHYTATE.

This salt is obtained when the octa-silver phytate, dissolved in dilute nitric acid, is precipitated with alcohol. The precipitate after filtering, washing and drying as before was analyzed. In appearance and properties it was identical with the octa salt.

For $C_6H_{17}O_{27}P_6Ag_7 = 1462$
Calculated Ag 51.64: P 12.72 per ct.
Found Ag 52.43: P 13.02 per ct.

DI-PYROPHOSPHORIC ACID ESTER OF INOSITE.

Dry pyrophosphoric acid 17.02 gm. (little over 9 mol.) was heated in a flask in an oil bath to about 200°C. and 5.4 gm. (3 mol.) dry inosite added. At this temperature the inosite dissolved at once forming a thick reddish-brown colored solution. After heating to 220° for a few minutes the flask was removed and allowed to cool. The reaction mixture was dissolved in 500 cc. of water, 20 cc. 5/N hydrochloric acid added and the whole boiled for about one hour. At the end of this time the excess of the pyrophosphoric acid has become changed to orthophosphoric acid and as such does not interfere with the precipitation of the barium salt of the ester with alcohol.

After cooling the above solution containing the new ester it was diluted to 1 liter with water, a solution of 40 gm. of barium chloride in water was added and the barium salt of the ester was then pre-

cipitated by adding 1 liter of alcohol. The resulting precipitate was filtered off at once and for the purpose of removing adhering inorganic phosphate was precipitated twice from 0.5 per ct. hydrochloric acid, in the presence of a small quantity of barium chloride, with alcohol and then twice from the same strength hydrochloric acid with alcohol. After finally filtering and thoroughly washing in 50 per ct. alcohol, alcohol and ether it was dried in vacuum over sulphuric acid. The product so obtained was a white amorphous powder. In appearance it was very similar to the tribarium phytate and the barium salt of the tetra phosphoric acid ester of inosite except that when precipitated with alcohol the particles appeared coarser. On moist litmus paper it showed a strong acid reaction. It was readily soluble in dilute hydrochloric and nitric acids, less soluble in acetic acid, very slightly soluble in water and exceedingly soluble in 10 per ct. phytic acid. It was free from chlorine. Yield 11 8 gm.

After drying at 105° in vacuum over phosphorus pentoxide the substance was analyzed.

0.2617 gm. subst. gave 0.0421 gm. H_2O and 0.1016 gm. CO_2
0.2796 gm. subst. gave 0.0488 gm. H_2O and 0.1080 gm. CO_2
0.2566 gm. subst. gave 0.1495 gm. $BaSO_4$ and 0.1443 gm. $Mg_2P_2O_7$
Found: C 10.58: H 1.80: P 15.67: Ba 34.28 per ct.
C 10.53: H 1.95 per ct.

The substance was not yet pure being probably mixed with some monopyrophosphoric acid ester of inosite; at least the high carbon and low phosphorus points to such a conclusion.

It was hoped that the exceeding solubility of the substance in phytic acid might serve to separate these bodies. For this purpose the whole substance was dissolved in 20 cc. 10 per ct. phytic acid. On diluting with water a portion of the substance separated as a heavy granular powder. To complete the separation 100 cc. of water was added and then allowed to stand two days at room temperature. This precipitate was discarded; as analysis, after purifying by precipitating from 0.5 per ct. hydrochloric acid with alcohol, showed that it was still impure and only 0.9 gm. had been obtained. The great bulk of the substance was accordingly contained in the filtrate from the above. This filtrate was diluted to 300 cc. with water and then precipitated by adding 300 cc. alcohol. The voluminous white precipitate was filtered off, washed thoroughly in 50 per ct. alcohol and alcohol. For purification it was dissolved in 0.5 per ct. hydrochloric acid and precipitated by alcohol. After filtering and thoroughly washing in dilute alcohol until free from chlorine it was washed in alcohol and ether and dried in vacuum over sulphuric acid. The product so obtained was a pure white amorphous powder. On moist litmus paper it showed a strong

acid reaction. The solubility corresponded with that previously observed. Yield 7.7 gm.

For analysis it was dried at 105° in vacuum over phosphorus pentoxide.

0.2914 gm. subst. gave 0.0440 gm. H_2O and .1026 gm. CO_2.
0.1667 gm. subst. gave 0.0977 gm. Ba So_4 and 0.0960 gm. $Mg_2P_2O_7$.

For $C_6H_6(OH)_4\ O_2(P_2O_6HBa)_2 = 770.7$
Calculated C 9.34: H 1.55: P 16.08: Ba 35.64 per ct.
Found C 9.60: H 1.68: P 16.05: Ba 34.48 per ct.

The barium was found to be a little low but this is compensated for through a slightly high carbon content; moreover it is sometimes difficult to obtain amorphous salts of this kind which show closer agreement than the above. The analysis leaves no doubt that the substance was the barium salt of the ester in question. It will be noticed that the dipyrophosphoric acid ester is isomeric with the tetraphosphoric acid ester of inosite previously referred to. Lack of time has prevented the determination of the free alcoholic (OH) groups in the inosite ring in either of these compounds. Experiments along this line are contemplated, however.

That the reaction between the inosite and the pyrophosphoric acid actually occurred along the lines discussed above may be judged by the amount of water given off. To determine this point 0.36 gm. inosite (one mol.) and 1.06 gm. pyrophosphoric acid (3 mol.) both previously dried at 100° C. were heated in a small flask in oil bath at 200°–220° under the same conditions as in the above experiment. The water, which began to come over at a temperature of about 200°, was collected in a weighed calcium-chloride tube. The aqueous vapors were removed by means of the suction pump but no special effort was made to secure quantitative results. The water obtained weighed 0.0494 gm. whereas the quantity calculated for 2 mol. H_2O is 0.072 gm. The amount obtained is therefore only about 68 per ct. of the theory.

PREPARATION OF THE FREE DIPYROPHOSPHORIC ESTER.

The air-dried barium salt of the ester (4 gm.) was suspended in water and decomposed with a slight excess of sulphuric acid, the barium sulphate was removed and the solution precipitated with copper acetate. The copper salt was filtered off, thoroughly washed in water, suspended in water and decomposed with hydrogen sulphide. It was found impossible to remove the copper sulphide completely by filtration as it formed a colloidal solution, but by acidifying with a few drops of hydrochloric acid and heating to boiling the copper sulphide precipitated. After filtering, the filtrate was evaporated several times in vacuum for the removal of the hydrochloric

acid and finally dried in vacuum over sulphuric acid and potassium hydroxide until it was of a thick syrupy consistency. The product obtained was of the same appearance as phytic acid or the tetra-phosphoric ester, viz.: a thick, light amber colored liquid. After drying at 105° the substance was analyzed.

0.1709 gm. subst. gave 0.0552 gm. H_2O and 0.0892 gm. CO_2.
0.1739 gm. subst. gave 0.1517 gm. $Mg_2P_2O_7$.

For $C_6H_6(OH)_4O_2\ [P_2O_3(OH)_3]_2 = 500$
Calculated C 14.40: H 3.20: P 24.80 per ct.
Found C 14.23: H 3.61: P 24.31 per ct.

PROPERTIES OF THE FREE DIPYROPHOSPHORIC ESTER.

The concentrated aqueous solution is a thick, light amber colored syrup. On longer drying over sulphuric acid it becomes a hard and brittle hygroscopic mass.

The aqueous solution is of strong acid reaction and sharp acid taste.

With barium chloride no precipitate is produced either in the cold or on heating; alcohol or ammonia produces a white precipitate in this solution.

Calcium chloride gives no precipitate even on heating but alcohol causes in this solution a voluminous flocculent precipitate.

Calcium acetate produces at once a white precipitate sparingly soluble in acetic but readily soluble in mineral acids.

Magnesium acetate gives a white precipitate readily soluble in acids.

Ferric chloride gives a white or faintly yellowish precipitate very sparingly soluble in acids.

Barium acetate gives a white precipitate sparingly soluble in acetic acid but readily soluble in dilute hydrochloric or nitric acids.

Dilute silver nitrate does not cause a precipitate but concentrated silver nitrate gives a white precipitate.

With ordinary molybdate solution no precipitate is produced but neutral molybdate gives a white precipitate which slowly turns yellowish in color. On drying at 105° the substance turns very dark in color.

INOSITE FROM DI-PYROPHOSPHORIC ESTER.

The free ester, 0.65 gm., was heated with 20 cc. 5/N sulphuric acid in sealed tube to 150° for about three hours. The inosite was isolated by the usual method and crystallized from dilute alcohol after addition of ether. After recrystallizing from hot dilute alcohol, adding ether and allowing to stand several hours in the cold, the substance was obtained in small colorless crystals free from water of crystallization: Yield 0.18 gm. or 75 per ct. of the theory. The

air-dried, water-free substance melted at 221° C. (uncor.) and it gave the reaction of Scherer. Drying at 110° for one hour caused no loss of weight. On analysis the following results were obtained:
0.1634 gm. subst. gave 0.0981 H_2O and 0.2374 gm. CO_2.

For $C_6H_{12}O_6 = 180$
Calculated C 40.00: H 6.66 per ct.
Found C 39.62: H 6.71 per ct.

DI-INOSITE TRIPYROPHOSPHORIC ACID ESTER

This ester is formed when dry inosite is heated with excess of pyrophosphoric acid. The molecule of the new ester evidently consists of two molecules dipyrophosphoric acid esters of inosite joined by one molecule of pyrophosphoric acid.

Dry inosite 1.8 gm. (1 mol.) were heated with 10.7 gm. (6 mol.) pyrophosphoric acid under the same conditions as described for the dipyrophosphoric ester and it was isolated as the barium salt in exactly the same way. After precipitating five times from 0.5 per ct. hydrochloric acid with alcohol the product was finally obtained as a perfectly white amorphous powder. Its solubilities corresponded practically with those mentioned for the dipyrophosphoric acid ester and likewise it showed a strong acid reaction on moist litmus paper.

For analysis it was dried at 105° in vacuum over phosphorus pentoxide.

0.2086 gm. subst. gave 0.0296 gm. H_2O and 0.0614 gm. CO_2.
0.1412 gm. subst. gave 0.0879 gm. $BaSO_4$ and 0.0844 gm. $Mg_2P_2O_7$.
Found C 8.02: H 1.58: P 16.66: Ba 36.63 per ct.

This substance was then again precipitated twice from 0.5 per ct. hydrochloric acid with alcohol and after drying at 105° gave the following result on analysis:

0.2420 gm. subst. gave 0.0342 gm. H_2O and 0.0725 gm. CO_2.
0.2331 gm. subst. gave. 0.1422 gm. BaSO and 0.1384 gm. $Mg_2P_2O_7$.

For $C_{12}H_{22}O_{41}P_{10}Ba_5 = 1818$
Calculated C 7.92: H 1.21: P 17 05: Ba 37 73 per ct.
Found I C 8.02: H 1.58: P 16.66: Ba 36.66 per ct.
Found II C 8.17: H 1.58: P 16.55: Ba 35.90 per ct.

As repeated precipitations did not alter the composition it was undoubtedly a homogeneous compound. The barium was found to be too low, but as previously remarked, it is difficult to obtain these amorphous salts in absolutely pure form. The percentage of the base combined with the acid is apt to vary more or less, depending upon conditions. The analysis of the free ester leaves no doubt but that the substance was the compound in question.

PREPARATION OF THE FREE DI-INOSITE TRI-PYROPHOSPHORIC ACID ESTER.

The purified dry barium salt (1.5 gm.) was suspended in water, decomposed with slight excess of sulphuric acid, the barium sulphate removed and the solution precipitated with copper acetate. The copper salt was decomposed and the free ester obtained in exactly the same way as described for the di-pyrophosphoric ester.

In this case also the copper sulphide could be precipitated only after the solution had been acidified with hydrochloric acid. For the removal of the hydrochloric acid the filtrate was evaporated several times in vacuum with water and finally dried in vacuum over sulphuric acid and potassium hydroxide. The product, like the previous compound, was a thick, light amber colored syrup. For analysis it was dried at 105° C.

0.1607 gm. subst. gave 0.0466 gm. H_2O and 0.0744 gm. CO_2.
0.1083 gm. subst. gave 0.1030 gm. $Mg_2P_2O_7$.

For $C_{12}H_{32}O_{41}P_{10} = 1142$
Calculated C 12.60: H 2.80: P 27.14 per ct.
Found C 12.62: H 3.24: P 26.51 per ct.

PROPERTIES OF THE DI-INOSITE TRI-PYROPHOSPHORIC ESTER

The properties of this ester agree in the main with those mentioned of the di-pyrophosphoric ester. The concentrated solution of the ester forms a thick, light amber colored syrup which on longer drying in desiccator becomes brittle and hygroscopic. The aqueous solution is of strong acid reaction and pleasant acid taste. The precipitates produced with calcium, magnesium, silver and iron salts are identical with those given by the di-pyrophosphoric ester.

Barium chloride produces at once a white precipitate sparingly soluble in acetic but readily soluble in dilute hydrochloric and nitric acids.

Ordinary molybdate solution produces a white precipitate which does not turn yellowish in color, being in this respect identical with phytic acid.

Neutral molybdate solution causes at first a voluminous white precipitate which redissolves almost immediately. The addition of a few drops of the ordinary acid molybdate to this solution and scratching with a glass rod causes the separation of long white needle-shaped crystals. The crystals and the precipitate caused by the ordinary molybdate solution are readily soluble in ammonia.

On drying at 105° the substance turns very dark in color.

Lack of material prevented the hydrolysis of this ester and the isolation of inosite as one of the products of decomposition had therefore to be omitted.

THE ORGANIC-PHOSPHORIC ACID COMPOUND OF WHEAT BRAN: PRELIMINARY REPORT.*

(THIRD PAPER ON PHYTIN.)

R. J. ANDERSON.

SUMMARY.

In the examination of the organic-phosphoric acid compound of wheat bran none of the characteristic salts of phytic acid could be isolated.

The purified barium salts of the compound corresponded to the following formulas: $C_{25} H_{55} O_{54} P_9 Ba_5$ and $C_{20} H_{45} O_{49} P_9 Ba_5$.

Attempts to isolate the free acid corresponding to the first salt did not succeed. From both salts the same acid, corresponding to that of the second salt, $C_{20} H_{55} O_{49} P_9$ was obtained. This acid is apparently formed from the first by the splitting off of the elements of one pentose.

Crystalline salts of the acid $C_{20} H_{55} O_{49} P_9$ with inorganic bases could not be obtained. A crystalline brucine salt $C_{20} H_{55} O_{49} P_9 (C_{23} H_{26} O_4 N_4)_{10} + 30 H_2O$ was easily formed.

Since all the purified barium salts prepared under different conditions, either from the previously isolated crude substance or from the bran extract itself, could all finally be changed into salts of the acid $C_{20} H_{55} O_{49} P_9$ under liberation of reducing substances, the conclusion seems justified that this acid is the only organic-phosphoric-acid present and that wheat bran does not contain phytin.

INTRODUCTION.

In the last two papers dealing with the chemistry of phytin[1] various salts of phytic acid with inorganic bases have been described as well as various phosphoric and pyrophosphoric acid esters of inosite. In connection with the above work the subject of the organic phosphorus compound of wheat bran was taken up.

Patten and Hart[2] had shown that wheat bran contains an organic-phosphorus body which on cleavage with 30 per ct. sulphuric acid in a sealed tube gave inosite as one of the products of decomposition. They also obtained an acid from a 0.2 per ct. hydrochloric acid extract of bran which on analysis gave results corresponding very closely with the theoretical composition of phytic acid or, as the substance was then called, "anhydro-oxymethylene di-phosphoric acid".

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[1] *Jour. Biol. Chem.* 11:471, and 12:97; and Technical Bulls. 19 and 21 of this Station.

[2] *Amer. Chem. Jour.* 31:565. 1904.

* A reprint of Technical Bulletin No. 22, September, 1912; also appeared in *Jour. Biol. Chem.* 11:447. 1912.

These results led the above authors to believe that the substance which they had isolated was identical with the organic-phosphorus compound described by Palladin,[1] Schulze and Winterstein,[2] and later by Winterstein,[3] and which was finally obtained in pure form by Posternak,[4] who gave the substance the name " phytin ".

The above substance, isolated by Patten and Hart and which they assumed to be phytin, has since then been regarded as such by other investigators, among whom may be mentioned Suzuki and Yoshimura,[5] Neuberg,[6] and Forbes.[7] These authors do not, however, report any complete analyses of the substance.

Since the investigation of the organic-phosphorus compound of wheat bran by Patten and Hart, several feeding experiments, some of which have not yet been published, to determine the physiological effect of phytin have been carried out at this institution by Dr. Jordan. In these experiments it has been found that the effect of pure phytin salts has been decidedly different from that obtained by feeding varying quantities of washed and unwashed wheat bran.[8] These anomalous results could not be explained on the assumption that only " phytin " was removed from the bran by washing. What still more complicated the problem was the fact that previous work had shown that very little besides phosphorus compounds and inorganic bases had been removed from the wheat bran in the process of washing or leaching.[9]

In the hope of throwing some light on this subject, the chemical investigation of the products removed from wheat bran by washing it in dilute acid was again taken up. The chief object was to isolate and identify the organic-phosphorus body and to determine what bases were associated with it.

If ordinary wheat bran be extracted with 0.2 per ct. hydrochloric acid and the resulting filtered extract precipitated with alcohol, a body is obtained which, after repeated precipitations from 0.2 per ct. hydrochloric acid with alcohol, shows a relatively uniform composition. The composition varies somewhat, depending upon the conditions under which the substance is prepared, but on an average it has been found to be about as follows: C 21.0, H 3.5, P 14.0 per ct. The substance also contains calcium, magnesium, potassium and sodium in varying amounts, together with traces of iron, and it always contains nitrogen varying from 2.1 to 0.4 per ct. The nitrogen, however, is not present as ammonia.

[1] *Ztschr. Biol.* **31**: 199. 1894.
[2] *Ztschr. physiol. Chem.* **22**: 90.
[3] *Ber. deut. Chem. Ges.* **30**: 2299.
[4] *Rev. Gen. Bot.* **12**: 5 and 65 (1900) and *Compt. Rend.* **137**: 202, 337 and 439 (1903).
[5] *Bull. Coll. Agric.* (Tokyo) **7**: 498.
[6] *Biochem. Ztschr.* **16**: 405.
[7] Ohio Agr. Exp. Sta. Bull. 215.
[8] *Amer. Jour. Physiol.* **16**: 268. 1906.
[9] *Ibid.* **16**: 274 and 304. 1906.

This compound reduces Fehling's solution on boiling. It gives reactions with orcine and phloroglucine and yields furfurol when distilled with 12 per ct. hydrochloric acid It was first described by Patten and Hart,[1] although they do not mention the above reactions. As previously stated, they considered it identical with phytin, although according to their analysis it had the following composition:

C 18.52, H 3.83, P 16.38, Ca 1.13, Mg 5.80, K 2.60, N 0.37 per ct.

It will be noticed at once that for a salt of phytic acid the above compound has about 10 per ct. *too much carbon* and about 6 per ct. *too little phosphorus.*

After isolating and purifying some of the substance, as will be described in the experimental part, a product was finally obtained which had the composition mentioned above, viz: C 21.0 per ct., etc. It was believed at first that it was an impure phytin compound, probably associated with some carbohydrate group and some complex nitrogen-containing body. All attempts to prepare any of the characteristic salts of phytic acid from the substance have failed. We have found, however, that it is possible by the action of barium hydroxide to separate the substance into two constituents: one an organic-phosphoric acid free from nitrogen, and a second body containing nitrogen.

The nitrogen-containing compound also contains phosphorus in organic combination. It has, however, not been obtained in pure form. It has not been analyzed and its nature is at present entirely unknown.

The barium salt of the nitrogen-free body corresponds to the formula $C_{25} H_{55} O_{54} P_9 Ba_5$. The isolation of the free acid, $C_{25} H_{65} O_{54} P_9$, corresponding to the above barium salt, has not succeeded. Attempts to isolate it led to an organic-phosphoric acid, lower in carbon and higher in phosphorus, of the composition $C_{20} H_{55} O_{49} P_9$. In the process of isolation apparently the elements of one pentose are split off:

$$C_{25} H_{65} O_{54} P_9 - C_5 H_{10} O_5 = C_{20} H_{55} O_{49} P_9.$$

If, in the preparation of the above barium salt from the crude substance, the solution is allowed to stand in contact with dilute hydrochloric acid for any length of time a barium salt is obtained corresponding to the second acid, $C_{20} H_{45} O_{49} P_9 Ba_5$ from which salt the free acid may be generated.

The barium salt, $C_{25} H_{55} O_{54} P_9 Ba_5$, yields furfurol on distillation with 12 per ct. hydrochloric acid but the salt $C_{20} H_{45} O_{49} P_9 Ba_5$ does not do so.

The acid, $C_{20} H_{55} O_{49} P_9$, apparently represents the nucleus of the molecule of the organic-phosphorus compound, as it has been found impossible to obtain any simpler organic-phosphoric acid from it by treatment with acids.

[1] *Loc. cit.*

On boiling with normal sulphuric acid at ordinary pressure it is slowly decomposed with formation of phosphoric acid and *reducing bodies*, apparently carbohydrates, as the solution reduces Fehling's solution and gives reactions with orcine and phloroglucine; but no trace of inosite could be isolated. The unchanged portion isolated from the reaction mixture has exactly the same composition as it had before boiling, which indicates that the molecule is gradually broken up into reducing bodies and phosphoric acid without suffering any intermediate or partial decomposition.

On heating the substance in a sealed tube with 5/N sulphuric acid the cleavage appears to go in another direction; for in this case 90 per ct. of the total carbon was recovered in the form of inosite and absolutely no reducing bodies were present in the reaction mixture. No explanation can be offered at this time concerning this peculiar behavior towards sulphuric acid under ordinary pressure and in a sealed tube.

It is evident that this compound is *not phytin*. The only similarity between these substances is found in that they are both organic-phosphoric acids and that when heated in a sealed tube with acids they yield inosite as one of the products of decomposition. Whether this new compound contains the inosite as such or whether it is only formed in the process of decomposition cannot be definitely determined at this time. However, if it were a complex compound of inosite and phosphoric or pyrophosphoric acid, the isolation of inosite should be possible after cleavage with dilute acid at ordinary pressure. As has been stated, this cannot be done and, moreover, the empirical formula of the substance can hardly be brought into accord with any inosite compound.

The substance is probably similar to, if not identical with, the glucophosphoric acid described by Levene.[1] The same author[2] also described an organic-phosphoric acid compound isolated from hemp seed which gave reactions for pentose or glucoronic acid. Since phytin does not give these reactions, as stated by Neuberg,[3] it is very probable that the products examined by Levene were of the same nature as that described in this paper.

The chief support of the assumption of Patten and Hart[4] that the organic-phosphorus compound of wheat bran was phytin was no doubt based upon the fact that they had obtained a substance from dilute hydrochloric-acid extract of bran which corresponded closely in composition with that required for the " anhydro-oxymethylene di-phosphoric acid " of Posternak.

Serious objection, however, must be raised against their method of isolating this substance in so far as they made absolutely no

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[1] *Jour. Amer. Chem. Soc* 24: 190 (1902), and *Amer. Jour. Physiol.* 8: XI (1903).
[2] *Biochem. Ztschr.* 16: 399.
[3] *Ibid.* 16: p. 405.
[4] *Loc. cit.*

effort to remove *inorganic phosphates*. From the work of Hart and Andrews[1] they believed themselves justified in considering the inorganic soluble phosphates present in wheat bran as a negligible quantity. While we cannot enter into any discussion of the above work here, it is to be noted that in the determination of the soluble inorganic phosphates in plant constituents Hart and Andrews extracted the material with 0.2 per ct. hydrochloric acid for 15 minutes and determined the inorganic phosphorus in the filtered extract by precipitating with nearly neutral ammonium molybdate. By this method they found 0.036 per ct. inorganic phosphorus in wheat bran. The total amount of phosphorus compounds soluble in 0.2 per ct. hydrochloric acid was found to be equivalent to 0.951 per ct. phosphorus.

The inorganic phosphorus found by the above authors is therefore equal to 3.78 per ct. of the total phosphorus soluble in 0.2 per ct. hydrochloric acid.

Suzuki and Yoshimura[2] report phosphorus determinations in wheat bran. They found 0.638 per ct. phosphorus soluble in 0.2 per ct. hydrochloric acid; of this, 0.050 per ct. was found to be inorganic, and 0.579 per ct. organic. The inorganic phosphorus found in this case is therefore equal to 8.63 per ct. of the total phosphorus soluble in 0.2 per ct. hydrochloric acid.

The work of Forbes and associates[3] seems to show that the time allowed by Hart and Andrews, 15 minutes, is not sufficient for complete extraction and that neutral molybdate solution is not suitable for precipitation in all cases; that when three hours is allowed for extraction a considerably larger amount of inorganic phosphorus is obtained.

In the preparation of the "phytin" products from wheat bran Patten and Hart[4] do not mention any definite time allowed for extraction but only state that "the bran was extracted for several hours with 0.2 per ct. hydrochloric acid," apparently therefore a longer time than allowed by Hart and Andrews in their determinations of inorganic-phosphorus.

When wheat bran is digested for several hours in 0.2 per ct. hydrochloric acid we have found that the resulting extract always contains a considerable quantity of inorganic phosphates. Quantitative determinations have, however, not been carried out and we are at present unable to state whether the inorganic phosphates were present in the bran originally or if they have been formed by hydrolysis of the organic-phosphorus compounds, but we purpose to take up this phase of the subject later.

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[1] N. Y. Agr. Exp. Station Bull. 238. 1903.
[2] *Bull. Coll. Agr.* (Tokyo) 7: 498.
[3] *Loc. cit.*
[4] *Loc. cit.*

On precipitating a bran extract, prepared as indicated above, with any of the usual reagents for the isolation of the organic-phosphorus compound the inorganic phosphates are more or less completely precipitated at the same time. In order to remove these inorganic phosphates we have found it necessary to repeatedly precipitate the substance from 0.2 or 0.5 per ct. hydrochloric acid with alcohol. In other words the substance has been re-precipitated until the dilute nitric acid solution of the resulting product does not give any immediate reaction with ammonium molybdate. The slight amount of phospho-molybdate precipitated from the solution on longer standing is no doubt due to cleavage rather than to admixed inorganic phosphates.

In order to determine if any barium salt of different composition from those discussed above could be prepared directly from wheat bran extract, the following experiment was carried out: The 0.2 per ct. hydrochloric acid extract of bran prepared as before was precipitated with barium chloride and alcohol. The substance was purified by precipitating from 0.5 per ct. hydrochloric acid solution with alcohol until it gave no immediate reaction with ammonium molybdate (compare experimental part).

Analysis showed that this compound contained a higher percentage of carbon and lower of phosphorus than the barium salt prepared from the previously isolated crude substance and it gave a larger amount of furfurol on distillation with 12 per ct. hydrochloric acid. By treating this compound with dilute sulphuric acid for a short time some reducing body was split off and the organic-phosporus substance finally isolated from the reaction mixture corresponded in composition with the barium salt first prepared, viz., $C_{25} H_{55} O_{54} P_9 Ba_5$. This compound is, however, easily transformed into $C_{20} H_{55} O_{49} P_9$ as has already been shown.

Since we have been unable to isolate any compound from wheat bran corresponding in composition to a salt of phytic acid we have come to the conclusion that wheat bran *does not contain phytin* and that the above compound $C_{20} H_{55} O_{49} P_9$ is the only organic-phosphoric acid existing in bran. It appears, however, that in its natural condition in the bran one or more as yet unidentified reducing bodies, yielding furfurol on distillation with hydrochloric acid, and which are easily split off by the action of dilute acids, are loosely bound to this nucleus.

The so-called "anhydro-oxymethylene di-phosphoric acid" analyzed by Patten and Hart was undoubtedly a mixture of the above compound and free phosphoric acid. This seems the more probable as they had not made any effort to remove inorganic phosphates in the preparation of their acid.

The empirical formulas suggested in this paper are of course purely tentative. We are now preparing larger quantities of the

substance from wheat bran and hope shortly to be able to report further concerning this compound. Various other cereals and feeding stuffs are also being examined to determine if they contain phytin or if this other organic-phosphoric acid compound is present.

EXPERIMENTAL.

PREPARATION OF THE ORGANIC-PHOSPHORUS COMPOUND FROM WHEAT BRAN.

The bran was digested with 0.2 per ct. hydrochloric acid over night and the extract after straining and filtering was precipitated with alcohol according to the method of Patten & Hart (loc. cit.). The resulting precipitate was purified by precipitating five times from 0.2 per ct. hydrochloric acid with alcohol. From 500 grams bran 2.5 grams substance was obtained as a white amorphous non-hygroscopic powder. It is readily soluble in its own weight of water, forming a thick light-amber-colored solution of pleasant and characteristic but faint acid odor. The substance reduces Fehling's solution on boiling and it gives the orcine and phloroglucine reactions. The aqueous solution is of acid reaction on litmus paper. It is precipitated by alkalies and solutions of salts of other metals. Warmed with dilute nitric acid and ammonium molybdate it does not give any immediate precipitate but on standing for several hours a trace of yellow phosphomolybdate is precipitated.

After drying at 120° the substance was analyzed.

0.1642 gram substance gave 0.0522 gm. H_2O and 0.1285 gm. CO_2.
0.0860 gram substance gave 0.0428 gm. $Mg_2P_2O_7$ for P.
0.1720 gram substance gave 0.0264 gm. $Mg_2P_2O_7$ for Mg.
0.1720 gram substance gave 0.0054 gm. CaO.
0.3897 gram substance gave 0.0085 gm. N (Kjeldahl).
The substance contained only a very small quantity of K.
Found C 21.34, H 3.55, P 13.87, Ca 2.24, Mg 3.35, N 2.18 per ct.

A larger quantity of the product was then prepared by extracting 3 kg. of bran. After isolating and purifying in the same way as before 47 grams substance was obtained or about 1.5 per ct. of the weight of the bran used. In appearance and properties it was identical with the foregoing.

After drying at 105° in vacuum over phosphorus pentoxide the substance was analyzed.

0.2444 gram substance gave 0.0710 gm. H_2O and 0.1940 gm. CO_2.
0.3936 gram substance gave 0.0149 gm. CaO and 0.0861 $Mg_2P_2O_7$.
0.3936 gram substance gave 0.0623 gm. K_2PtCl_6.
Phosphorus and nitrogen determinations were not made.
Found C 21.64, H 3.25, Ca 2.70, Mg 4.77, K 2.54 per ct.

The substance was again precipitated from 0.2 per ct. hydrochloric acid, washed and dried as before when the following results were obtained on analysis:

0.1934 gram substance gave 0.0639 gm. H_2O and 0.1523 gm. CO_2.

0.3313 gram substance gave 0.0131 gm. CaO and 0.0717 gm. $Mg_2P_2O_7$ for Mg.

0.3313 gram substance gave 0.0444 gm. K_2PtCl_6.

0.1656 gram substance gave 0.0857 gm. $Mg_2P_2O_7$ for P.

0.4639 gram substance gave 0.0058 gm. N (Kjeldahl).

Found C 21.47, H 3.69, P 14.42, Ca 2.82, Mg 4.72, K 2.15, N 1.25 per ct.

Sodium was not determined but qualitative tests showed that it was present.

The reprecipitated substance, 0.3887 gm., distilled with 12 per ct. HCl gave 0.0367 gm. phloroglucid.

As the composition did not change by reprecipitation it was deemed sufficiently pure to use in the subsequent experiments.

It was thought at first that this substance might be phytin mixed with some carbohydrate and some basic nitrogen body. In the hope of separating these and to obtain pure compounds the substance was treated with barium hydroxide and the resulting barium salt purified as follows:

PREPARATION OF THE BARIUM SALT.

Five grams of the substance were dissolved in 10 cc. of water and the solution diluted to 200 cc. with water. Barium hydroxide was then added until distinctly alkaline and the mixture heated nearly to boiling. It was then filtered hot and washed with hot water, the filtrate being reserved for examination.

The washed barium precipitate was dissolved in just sufficient 0.5 per ct. hydrochloric acid, filtered, again precipitated with barium hydroxide, the resulting precipitate dissolved by the careful addition of dilute hydrochloric acid and then precipitated by the addition of a like volume of alcohol. The substance was filtered, washed in dilute alcohol, again dissolved in 0.5 per ct. hydrochloric acid and precipitated in the same manner as before. These operations were repeated four times. It was then dissolved in the same strength hydrochloric acid, precipitated with alcohol, filtered, washed in dilute alcohol, alcohol and ether and dried in vacuum over sulphuric acid. The product was a perfectly white amorphous powder. Yield 3.9 grams.

The substance was slightly soluble in boiling water. On cooling, however, it does not crystallize out and on concentrating in vacuum it separates in an amorphous form. Alcohol also produces a white amorphous precipitate. Various other methods were tried to obtain the substance in crystalline form but without success. On moist

litmus paper it shows a strong acid reaction. It was free from nitrogen.

As it was found impossible to crystallize the substance it was analyzed directly after drying at 130°.

0.2564 grams substance gave 0.0604 gm. H_2O and 0.1314 gm. CO_2.

0.2903 grams substance gave 0.1544 gm. $BaSO_4$ and 0.1324 gm. $Mg_2P_2O_7$.

Found C 13.97, H 2.63, P 12.71, Ba 31.29 per ct.

Of this substance 1.2124 gm. was distilled with 12 per ct. HCl when 0.0053 gm. phloroglucid was obtained.

The composition of the above salt is entirely different from that of a barium phytate. The relation of the numbers found lead to the empirical formula $C_{25}\ H_{55}\ O_{54}\ P_9\ Ba_5{=}2185$.

Calculated for this C 13.73, H 2.51, P 12.76, Ba 31.44 per ct.

EXAMINATION OF THE FILTRATE FROM THE ABOVE COMPOUND AFTER PRECIPITATING WITH BARIUM HYDROXIDE.

The filtrate was of light amber color. The excess of barium hydroxide was removed with carbon dioxide, filtered and the filtrate concentrated on the waterbath; again filtered from traces of barium carbonate and then dried in vacuum over sulphuric acid. There remained a small quantity of a yellowish amber-colored, somewhat gummy mass. It contained a large quantity of nitrogen. It did not reduce Fehling's solution and gave only a faint biuret reaction.

The substance is readily soluble in water and is again precipitated by alcohol but it is not precipitated by tannic acid. The aqueous solution acidified with nitric acid gives no reaction with ammonium molybdate.

After combustion the ash was found to contain potassium, sodium and phosphorus. When the crude substance is treated by the Van Slyke method for amino nitrogen a small quantity of nitrogen is liberated.

Lack of time has prevented the further examination of this body and it has not been isolated in pure form.

ISOLATION OF THE FREE ACID FROM THE FOREGOING BARIUM SALT.

The barium salt (3.2 grams dry substance) was suspended in 100 cc. of water and decomposed with a slight excess of dilute sulphuric acid; the barium sulphate was removed by filtration and the filtrate precipitated with excess of copper acetate. The copper salt was filtered, thoroughly washed in water, suspended in water and decomposed with hydrogen sulphide. The copper sulphide was filtered off and the filtrate concentrated in vacuum to small bulk and finally dried in vacuum over sulphuric acid until it was of a thick syrupy consistency. After drying at 100° to constant weight the substance was analyzed.

0.2907 gram substance gave 0.1052 gm. H_2O and 0.1855 gm. CO_2.
0.1787 gram substance gave 0.0642 gm. H_2O and 0.1144 gm. CO_2.
0.1816 gram substance gave 0.1331 gm. $Mg_2P_2O_7$.
Found I C 17.40, H 4.04, P 20.43 per ct.
II C 17.46, H 4.02 per ct.
These results lead to the empirical formula $C_{20}\ H_{55}\ O_{49}\ P_9$.
Calculated for $C_{20}\ H_{55}\ O_{49}\ P_9$=1358.
C 17.67, H 4.05, P 20.54 per ct.

This compound differs in composition from the barium salt from which it was prepared by $C_5\ H_{10}\ O_5$; in other words by the elements of one pentose. This had probably been split off in the decomposition of the barium salt with the dilute sulphuric acid or else by the copper acetate, and if so should be found in the filtrate after the copper salt of the acid had been removed. The filtrate was therefore examined as follows: The copper was removed by hydrogen sulphide and the filtrate, after boiling off excess of H_2S, was precipitated with excess of barium hydroxide; filtered, and the barium precipitated quantitatively with sulphuric acid and the resulting filtrate evaporated to small bulk in vacuum. The solution was then found to reduce Fehling's solution on boiling and ammoniacal silver nitrate was also reduced. Unfortunately the substance obtained was too small for any further examination. There is, however, absolutely no doubt that a reducing body was present and this was most likely the above mentioned pentose.

PROPERTIES OF THE FREE ACID,

$C_{20}\ H_{55}\ O_{49}\ P_9$.

Dried in the desiccator it forms first a light-amber-colored thick syrup which on continued drying forms a thick sticky mass. It is very soluble in water and also readily soluble in alcohol from which solution it is thrown out by the addition of ether as a white precipitate which collects on the sides of the test tube in small oily drops.

The aqueous solution has a strong acid reaction and a pleasant sharp acid taste and it gives the following reactions:

Magnesium acetate does not give a precipitate but the addition of calcium acetate, barium chloride or alcohol causes in this solution a white precipitate.

Silver nitrate does not produce any precipitate but the addition of alcohol gives a white amorphous precipitate of the silver salt.

It is not precipitated by barium or calcium chlorides but the acetates of these metals and their hydroxides give white amorphous precipitates which are soluble in acetic and mineral acids.

Ferric chloride causes a white precipitate which is readily soluble in dilute hydrochloric or nitric acids.

The alkali salts are very soluble in water but in these solutions salts of the alkaline earths or the heavy metals produce white

precipitates. The addition of alcohol also produces white precipitates.

The ordinary molybdate solution does not give any precipitate in dilute solutions of the acid; in concentrated solutions a yellowish white precipitate is obtained. On acidifying with nitric acid and heating, the yellow phospho-molybdate is slowly precipitated.

The aqueous solution of the acid is only incompletely precipitated by magnesia mixture. A slight white-colored amorphous precipitate is obtained but the addition of alcohol produces a voluminous white precipitate. This product is, however, not a pure salt as shown by the following results which were obtained on analysis of the dried precipitate:

Found Mg 11.29, N 2.40, P 16.45 per ct., which numbers do not agree with any formula for a pure magnesium ammonium salt of the above acid.

A larger quantity of the barium salt was prepared by treating 25 grams of the substance with barium hydroxide and purifying the barium salt in the same way as before, except that after precipitating the dilute hydrochloric-acid solution with alcohol the mixture was allowed to stand for several days.

After drying at 125° the following results were obtained on analysis:

C 12.05, H 2.46, P 13.83, Ba 32.19 per ct.

C 11.85, H 2.32, P 13.82, Ba 32.08 per ct.

Although the barium is found somewhat low this salt corresponds to the penta-barium salt of the acid $C_{20} H_{55} O_{49} P_9$.

For $C_{20} H_{45} O_{49} P_9 Ba_5 = 2035$.

Calculated C 11.79, H 2.21, P 13.71, Ba 33.76 per ct.

The free acid prepared from this salt by the same method as before gave the following results on analysis after previously drying at 130°.

C 16.91, H 3.96, P 20.88 per ct.

C 16.91, H 3.84.

It appears then that the substance $C_{25} H_{65} O_{45} P_9$ is very sensitive to acids and that when it is kept in contact with even dilute acids for any length of time the elements of one pentose, $C_5 H_{10} O_5$, are split off.

BRUCINE SALT OF THE ACID,

$C_{20} H_{55} O_{49} P_9$.

While it was impossible to obtain any crystalline salts of the above acid with inorganic bases it gave a crystalline brucine salt of the formula $C_{20} H_{55} O_{49} P_9 (C_{23} H_{26} O_4 N_2)_{10} + 30 H_2O$.

About one gram of the acid was dissolved in a small quantity of water and brucine was then added until the solution showed a slight alkaline reaction. After diluting the solution with 150 cc. alcohol and 30 cc. chloroform, ether was added until a slight permanent turbidity remained. On standing for several days at room tempera-

ture in a well-closed Erlenmeyer flask the substance separated slowly in long white silky needle-shaped crystals.

In the absence of chloroform or in more concentrated solutions only amorphous white precipitates are obtained.

The crystals were filtered off and washed in a mixture containing equal parts of alcohol and ether and finally in ether and dried in the air. Yield about 0.5 grams.

The substance is very soluble in water, readily soluble in alcohol, but insoluble in ether or chloroform.

Heated in a capillary tube the substance melts at 196°–198°, but the melting point is not sharp. On moist litmus paper it shows a strong acid reaction. It loses weight on drying corresponding to 30 H_2O. The dried substance was analyzed.

0.1364 gm. substance lost 0.0124 gm. H_2O and 0.1308 gm. substance lost 0.0118 gm. H_2O.

0.1240 gm. substance gave 0.0694 gm. H_2O and 0.2557 gm. CO_2.

0.1383 gm. substance gave 0.0233 gm. $Mg_2P_2O_7$.

0.1190 gm. substance gave 6.1 cc. nitrogen by 16° and 746 mm.

For $C_{20} H_{55} O_{49} P_9 (C_{23} H_{26} O_4 N_2)_{10} = 5298$.

Calculated C 56.62, H 5.94, P 5.26, N 5.28 per ct.

Found C 56.24, H 6.26, P 4.69, N 5.86 per ct.

Calculated for 30 H_2O 9.24 per ct.; found 9.09 and 9.02 per ct.

ACTION OF DILUTE SULPHURIC ACID ON THE BARIUM SALT.

Five grams of the air-dried salt, $C_{20} H_{45} O_{49} P_9 Ba_5$, were boiled for one hour under a reflux condenser with 100 cc. N/1 $H_2 SO_4$. The reaction mixture was precipitated with slight excess of barium hydroxide, filterd and washed with water. The filtrate was examined as mentioned below.

The barium precipitate was shaken up with 300 cc. 0.5 per ct. hydrochloric acid and the insoluble portion filtered off. To the filtrate was added an equal volume of alcohol and the white flocculent precipitate filtered off and washed in dilute alcohol. It was again dissolved in 0.5 per ct. hydrochloric acid, precipitated with alcohol, filtered, washed free of hydrochloric acid with dilute alcohol and then in alcohol and ether and dried in vacuum over sulphuric acid. Yield 2 grams. The product was a white amorphous powder. After drying at 120° the following results were obtained on analysis:

Found C 11.64, H 2.25, P 13.95, Ba 33.26 per ct.

This corresponds exactly with the composition of the substance before treatment with N/1 $H_2 SO_4$. It is apparent therefore that no partial decomposition takes place.

EXAMINATION OF THE FILTRATE FROM ABOVE.

The excess of barium hydroxide was removed with carbon dioxide and, after filtering, the filtrate was concentrated in vacuum at a

temperature of 35°–40° to small bulk, again filtered and finally dried in vacuum over sulphuric acid. There remained 0.08 gram of a slightly amber-colored amorphous mass of weak acid reaction on litmus paper and a slight acid taste. The aqueous solution reduced Fehling's solution strongly on boiling, and it also gave the orcine and phloroglucine reactions. The small quantity of the substance prevented any further examination.

In another case $2\frac{1}{2}$ grams of the same barium salt were boiled with 100 cc. N/1 H_2SO_4 under reflux condenser for ten hours. After treating in the same way as above 0.3 gm. unchanged substance was obtained and the filtrate showed exactly the same properties as mentioned above. That is, it reduced Fehling's solution strongly on boiling, gave the reactions with orcine and phloroglucine, but attempts to isolate inosite failed, as no trace of this substance could be found.

PREPARATION OF INOSITE FROM THE BARIUM SALT.

Of the same barium salt ($C_{20}H_{45}O_{49}P_9Ba_5$) 2.73 grams and 20 cc. 5/N H_2SO_4 were heated in a sealed tube for three hours to 160°. There was no pressure noticeable on opening the tube. Some free carbon had separated and the solution was of light-brown color. The neutralized solution did not reduce Fehling's solution. The inosite was isolated in the usual way, and after re-crystallizing from dilute alcohol and ether was obtained in needle-shaped crystals free from water of crystallization. It gave the reaction of Scherer and melted at 220.5° (uncorrected), which leaves no doubt but that the substance was pure inosite. Yield 0.73 gm., which is equal to 90 per ct. of the total carbon present in the barium salt used. The air-dried substance was analyzed.

0.1649 gm. substance gave 0.1038 gm. H_2O and 0.2406 gm. CO_2.
0.1323 gm. substance gave 0.0815 gm. H_2O and 0.1931 gm. CO_2.
For $C_6H_6(OH)_6 = 180$.

Calculated	C 40.00 H 6.66 per ct.
Found	C 39.80 H 7.04 per ct.
	C 39.80 H 6.89 per ct.

The 0.2 per ct. hydrochloric acid extract of bran contains some dissolved proteins. On precipitating with alcohol these are thrown down together with the phosphorus compounds. Their presence makes the subsequent purification difficult, especially the filtrations, because the proteins have been rendered more or less insoluble and form a fine slimy mass which clogs the filter paper to such an extent as to make filtration even by suction extremely tedious.

In order to obviate this the suggestion was made by Dr. Jordan to first precipitate the bran extract with tannic acid.

The addition of tannic acid was found to cause a voluminous and very fine precipitate which after standing a short time becomes

coarser and may then be easily removed by simple filtration. The resulting filtrate is nearly colorless or of light amber color. Alcohol produces in this solution a nearly colorless precipitate which is much more easily purified than the product obtained without first precipitating with tannic acid.

With only this modification some of the substance was prepared from wheat bran. It was found, however, to differ slightly in composition from that obtained by the first method. On analysis the following results were obtained: C 19.51, H 3.09, P 15.23, Ca 0.38, Mg 7.35, K 2.75, N 0.57 per ct.

On treating this substance with barium hydroxide and purifying the resulting precipitate in the same way as before the same barium salt was obtained:

For $C_{25} H_{55} O_{54} P_9 Ba_5$=2184.

Calculated C 13.73, H 2.51, P 12.76, Ba 31.44 per ct.

Found C 13.00, H 2.46, P 12.47, Ba 33.00 per ct.

The difference in composition of the crude substance must therefore be due to the smaller amount of the nitrogen-containing body which this preparation was found to hold. In the analysis of the crude substance only 0.57 per ct. nitrogen was found, whereas the first preparation had four times, and the second preparation two times as much.

ISOLATION OF THE SUBSTANCE AS A BARIUM SALT DIRECTLY FROM THE BRAN EXTRACT.

The bran was digested with 0.2 per ct. hydrochloric acid over night The strained extract was precipitated with tannic acid, filtered, and a solution of barium chloride added, which caused a small precipitate to separate. An equal volume of alcohol was then added. After settling, the precipitate was filtered and purified as follows: The substance was dissolved in 0.5 per ct. hydrochloric acid, precipitated with barium hydroxide in excess, filtered, again dissolved in the same strength hydrochloric acid and then precipitated with alcohol. It was then precipitated a second time with barium hydroxide, and after that precipitated from 0.5 per ct. hydrochloric acid with alcohol until the product did not give any reaction with ammonium molybdate.

A white amorphous powder was finally obtained. On moist litmus paper it showed a strong acid reaction. After drying at 105° in vacuum over phosphorus pentoxide it was analyzed:

0.2870 gm. substance gave 0.0630 gm. H_2O and 0.1584 gm. CO_2.

0.3066 gm. substance gave 0.0653 gm. H_2O and 0.1700 gm. CO_2.

0.2632 gm. substance gave 0.1437 gm. $BaSO_4$ and 0.1020 gm. $Mg_2P_2O_7$.

Found I C 15.05, H 2.45, P 10.80, Ba 32.12 per ct.
II C 15.12, H 2.38.

Distilled with 12 per ct. HCl 0.4736 gm. substance gave 0.071 gm. phloroglucid.

As will be noticed, this compound contains a considerably larger percentage of carbon than any of the previous preparations and a correspondingly low percentage of phosphorus. Calculated on the same basis as before, it would correspond to a molecule with C 30 or C 32. By acting upon this compound with dilute sulphuric acid some reducing body is split off and the salt $C_{25}H_{55}O_{54}P_9Ba_5$ results, identical with that obtained in the first case from the crude substance.

One gram of the above barium salt was digested for about ten minutes with 20 cc. normal sulphuric acid and heated nearly to boiling. It was then precipitated with excess of barium hydroxide and filtered.

The filtrate was freed from excess of barium hydroxide with carbon dioxide, filtered and evaporated to small bulk, and again filtered. It was then found to reduce Fehling's solution strongly on boiling and to give the orcine and phloroglucine reactions, showing conclusively that a reducing body of some kind had been split off by the action of the sulphuric acid.

The barium precipitate from the above was shaken up with a small quantity of 0.5 per ct. hydrochloric acid, filtered, and the filtrate precipitated by adding an equal volume of alcohol. After again precipitating in the same manner the substance was filtered, washed in dilute alcohol, alcohol and ether, and dried in vacuum over sulphuric acid. The substance weighed 0.45 grams. For analysis it was dried at 105° in vacuum over phosphorus pentoxide.

0.2326 gm. substance gave 0.0525 gm. H_2O and 0.1208 gm. CO_2.

0.1859 gm. substance gave 0.1009 gm. $BaSO_4$ and 0.0804 gm. $Mg_2P_2O_7$.

Found C 14.16, H 2.52, P 12.05, Ba 31.94 per ct.

Calculated for $C_{25}H_{55}O_{54}P_9Ba_5=2184$.

C 13.73, H 2.51, P 12.76, Ba 31.44 per ct.

This substance is therefore identical with the barium salt prepared from the previously isolated crude compound.

We are planning to carry out a complete investigation concerning this organic-phosphoric acid of wheat bran and its cleavage products. It is desired especially to isolate and identify the reducing bodies formed on cleavage with dilute acid. We also wish to take up the study of the nitrogen-containing substance and beg to reserve the further investigation of these bodies.

THE ORGANIC PHOSPHORIC ACID OF COTTON-SEED MEAL.*

R. J. ANDERSON.

SUMMARY.

Cottonseed meal contains an organic phosphoric acid which is very similar to phytic acid. When heated in a sealed tube with dilute sulphuric acid it decomposes into inosite and phosphoric acid. Whether the substance is identical with phytin could not be determined. The acid gives easily crystallizing barium salts.

The aqueous solution of the free acid gives all those reactions which have been attributed previously to the presence of pyro- and metaphosphoric acids in cottonseed meal.

The acid when given in 0.5 and 1 gram doses to rabbits does not show any marked toxic properties. Symptoms of distress were produced but the animals recovered their normal appearance after two or three hours.

INTRODUCTION.

In the investigation of the organic phosphoric acids present in various cereals and feeding stuffs which is being carried out in this laboratory, cottonseed meal was also examined. Earlier work by other investigators has shown that this product probably contains some complex organic phosphoric acid.[1] It seems, however, that if such a substance is present it has not been isolated in pure form nor have its properties been fully studied.

The opinion seems to be generally held that cottonseed meal contains some poisonous principle, but the exact nature of this principle has never been definitely determined. It has been claimed that pyro- and metaphosphoric acids were present in cottonseed meal[2] and it was thought that the poisonous properties of the product were due to the presence of salts of these acids. More recent work by Crawford[3] led him to believe that the poisonous principle was a salt of either a simple inorganic or a complex organic pyrophosphoric acid.

The presence of these acids has been adduced from the fact that the extracts of cottonseed meal give reactions similar to those of the above acids, viz., anomalous behavior towards ammonium molybdate, white precipitates with silver nitrate and coagulation of egg albumen; further, the poisonous effects resemble those given by these acids. Aside from these reactions, however, there is no

[1] Rather, Texas Agr. Exp. Sta. Bull. 146 (1912); see p. 176 of this Report.

[2] Hardin, So. Carolina Agr. Exp. Sta. Bull. 8, New Series (1892).

[3] Crawford, *Jour. Pharm. and Exper. Ther.* 1: 519 (1910).

* A reprint of Technical Bulletin No. 25, December, 1912.

proof whatever that either pyro- or metaphosphoric acid is present in cottonseed meal.

The purpose of the present investigation was to isolate and identify, if possible, the organic phosphoric acid in cottonseed meal. We are, consequently, unable either to deny or affirm the absence or presence of pyro- or metaphosphoric acid in this product. We have found, however, that the organic phosphoric acid isolated from cottonseed meal gives all the reactions reported by the above authors, which they considered as evidence of the presence of pyro- and metaphosphoric acid. It seems, therefore, probable that the reactions referred to are due to the organic phosphoric acid rather than to pyro- or metaphosphoric acids.

The preparation of the substance and its purification will be more fully described in the experimental part. It will suffice to state here that cottonseed meal was extracted with 0.2 per ct. hydrochloric acid and the substance isolated as the barium salt. The purification of the substance is very difficult. The extract contains large quantities of soluble impurities, mucilaginous substances, proteins, etc., which render the purification extremely difficult and tedious. In addition to the above, there is apparently some carbohydrate associated with the organic phosphoric acid, the removal of which requires much time. For the same reasons the yield of the pure product is very unsatisfactory.

The compound finally obtained is very similar to phytic acid so far as composition and reactions are concerned. In fact it is impossible, from the present data, to determine whether the substance is phytic acid or an isomer. Both yield inosite when heated in a sealed tube with dilute sulphuric acid and the reactions of aqueous solutions of the free acids can hardly be differentiated.

The most striking difference is that the barium salt of the product from cottonseed meal shows a decided tendency to crystallize, a property which we have never observed when working with barium phytate under the same conditions.

If the substance from cottonseed meal is precipitated from acid solutions with barium hydroxide it separates as a white amorphous precipitate. When the dried precipitate is digested in 0.5 per ct. hydrochloric acid it dissolves very readily but after a few minutes it precipitates again. Under the microscope this precipitate is seen to consist of balls or globular masses of very fine needle-shaped crystals. The dilute hydrochloric acid solution of the barium salt gives a white amorphous precipitate on the addition of alcohol; by standing for several hours, however, it slowly assumes the same crystalline form as mentioned above. The free acid is not precipitated by barium chloride but if such a solution is allowed to stand over night or longer the barium salt will separate in fine needle-shaped crystals, grouped in the same general form as above but the individual crystals are much larger. The amorphous precipitates

are very soluble in 0.5 per ct. hydrochloric acid but after the substance has assumed the crystalline form, it is very slightly soluble in this medium.

While the barium salt was easily obtained in crystalline form it did not contain a constant amount of the base.

The variations would sometimes amount to as much as 3 or 4 per ct., depending upon the amount of the base present in the solution and the conditions under which the substance separated. In the presence of a large excess of barium chloride a salt corresponding nearly to tetrabarium phytate crystallizes out; when a small amount of barium chloride is present salts showing the above mentioned variations are formed; but when the substance has been repeatedly separated from acid solutions with alcohol a salt is obtained which corresponds nearly to tribarium phytate.

The aqueous solution of the free acid gives a heavy white amorphous precipitate with excess of silver nitrate; with ammonium molybdate a heavy white crystalline precipitate is produced which remains unchanged in the cold for a long time but when heated it soon turns yellowish in color. These reactions are identical with those given by phytic acid; with other metals both acids give apparently identical reactions.

The dilute aqueous solution of the acid coagulates egg albumen at once. This property, however, is not peculiar to the acid from cottonseed meal. Phytic acid was found to produce an identical effect. The tetraphosphoric acid ester of inosite[1] and the pyrophosphoric acid esters of inosite[2] mentioned in former papers also gave the same reaction. In view of the fact that the last mentioned substances coagulate egg albumen, it appears probable that this property is common to organically bound phosphoric acids.

As will be noticed from the foregoing the organic phosphoric acid of cottonseed meal gives all the reactions previously attributed to the presence of pyro- and metaphosphoric acids. But the question whether or not it is also the toxic principle in cottonseed meal remains unanswered. Preliminary experiments carried out with the acid obtained from the purified barium salt on rabbits are not conclusive. Given in 0.5 and 1 gram doses, both the free acid and its potassium salt produced strong symptoms of distress, but after a few hours the animals regained their normal appearance. Larger doses passed through the bowel in a very short time and no definite symptoms developed.

It is difficult to determine just what caused the toxicity of the preparations which were used in the experiments described by Crawford.[3] It is evident that very impure substances were given.

[1] Anderson, *Jour. Biol. Chem.* 11: 484 (1912) and Tech. Bull. No. 19, N. Y. Agr. Exp. Sta. (1912).

[2] Ibid, 12: 109 and 111 (1912) and Tech. Bull. No. 21, N. Y. Agr. Exp. Sta. (1912).

[3] Loc. cit.

It is our purpose to carry out a series of experiments to determine the toxicity of the acid from cottonseed meal in comparison with phytic acid.

EXPERIMENTAL.

The cottonseed meal used in these experiments was obtained from the stock used as cattle feed at this station. For the first preparation 4500 grams of meal were digested in 10 liters of 0.2 per ct. hydrochloric acid over night. It was then pressed through cheesecloth and the extract filtered through a layer of clean sand. The extract was a thick, mucilaginous, very dirty-colored liquid which could not be filtered through paper. It measured about 5 liters. It was mixed with about 8 liters of alcohol which produced a very fine and voluminous dirty precipitate. After settling over night the supernatant liquid was syphoned off and the residue centrifuged. The precepitate was then digested in a considerable quantity of 0.5 per ct. hydrochloric acid and the insoluble portion removed by centrifuging and the solution precipitated with excess of barium hydroxide. The mixture was heated nearly to boiling and then allowed to cool and settle. It was again centrifuged and the residue treated with 0.5 per ct. hydrochloric acid in which it was readily soluble. After a few minutes, however, it began to separate as a fine crystalline precipitate. The mixture was then filtered and the above precipitate reserved for special examination.

The filtrate was precipitated by the addition of alcohol, filtered, and again treated with 0.5 per ct. hydrochloric acid, filtered from insoluble matter and the filtrate again precipitated by alcohol. It was filtered and washed in dilute alcohol and then dissolved in 0.5 per ct. hydrochloric acid; heated nearly to boiling and filtered. The filtrate was now nearly colorless and it was slightly opalescent in appearance. After again precipitating the hydrochloric acid solution with alcohol the substance was obtained as a white amorphous powder. It was very soluble in 0.5 per ct. hydrochloric acid but the solution had a thick, mucilaginous and slightly opalescent appearance. This solution was now precipitated with excess of barium hydroxide when a voluminous, tenacious, ropy precipitate was obtained. The mixture was thoroughly shaken for some time and then filtered and washed in water. The washed residue was dissolved in 0.5 per ct. hydrochloric acid and precipitated with alcohol. After repeating this operation the substance was filtered, washed free of chlorides with dilute alcohol and finally washed in alcohol and ether and dried in vacuum over sulphuric acid. The product was then a snow-white amorphous powder and it weighed 10.2 grams.

It was but slightly soluble in boiling water. With phloroglucine and hydrochloric acid it gives a light red color which soon changes to a reddish-brown. With orcine it gives at first a reddish color which soon fades leaving a dirty-colored precipitate. After boiling

the substance in dilute hydrochloric acid, precipitating the barium with sulphuric acid, filtering and neutralizing, it strongly reduces Fehling's solution on boiling. The nitric acid solution gave no reaction with ammonium molybdate but after continued heating a slight precipitate was obtained. The substance was free from nitrogen and sulphur.

After drying at 105° in vacuum over phosphorus pentoxide it was analyzed.

0.2925 gram subst. gave 0.0894 gm. H_2O and 0.2338 gm. CO_2

0.2514 gram subst. gave 0.0972 gm. $BaSO_4$ and 0.0933 gm. $Mg_2P_2O_7$.

Found C = 21.80; H = 3.42; P = 10.34; Ba = 22.75 per ct.

While the substance was very slightly soluble in boiling water it was found when it was rubbed up in a mortar with a small quantity of cold water that it quickly dissolved but it began soon to separate again. Under the microscope the precipitate was seen to consist of small balls or globular masses of very fine microscopic needles.

Four grams of the substance were treated as mentioned above. After standing for two days at room temperature the crystalline precipitate was filtered off, washed in water, alcohol and ether and dried in the air. The snow-white crystalline powder was analyzed after previously drying at 105° in vacuum over phosphorus pentoxide.

0.2092 gram subst. lost 0.0291 gm. H_2O

0.1801 gram subst. gave 0.0232 gm. H_2O and 0.0379 gm. CO_2

0.1754 gram subst. gave 0.1262 gm. $BaSO_4$ and 0.0965 gm. $Mg_2 P_2 O_7$.

Found C = 5.73; H = 1.44; P = 15.33; Ba = 42.34; H_2O = 13.91 per ct.

The composition of this product differs entirely from that of the starting material but it agrees closely with that required for tetrabarium phytate.

Calculated for tetrabarium phytate, $C_6H_{16}O_{27}P_6Ba_4 = 1255$.

C = 5.73; H = 1.27; P = 14.82; Ba = 43.74; $11H_2O$ = 13.62 per ct.

The filtrate from the above crystalline compound was precipitated by alcohol, filtered, washed and dried in vacuum over sulphuric acid. It was a perfectly white amorphous powder. It was analyzed after drying at 105° in vacuum over phosphorus pentoxide.

0.1758 gram subst. gave 0.0790 gm. H_2O and 0.2222 gm. CO_2

0.1247 gram subst. gave 0.0223 gm. $BaSO_4$ and 0.0201 gm. $Mg_2P_2O_7$.

Found C = 34.47; H = 5.02; P = 4.49; Ba = 10.52 per ct.

The substance was very soluble in 0.5 per ct. hydrochloric acid in which it gave the same thick, mucilaginous, slightly opalescent solution as mentioned above.

The compound first analyzed is evidently not homogeneous. It apparently consists of some carbohydrate or gummy substance and an organic phosphorus compound; the latter crystallizes from the aqueous solution in nearly pure form but the substance cannot be separated by precipitating the dilute acid solutions with alcohol. This gummy substance has not been isolated in pure form and we are entirely in the dark as to its nature and composition.

A portion of the above crystalline barium salt was used for the preparation of the free acid. The substance was, however, not pure and it had not been washed free of the mother liquor. The acid was prepared by the usual method, that is, the barium salt was decomposed with a slight excess of sulphuric acid, the filtered solution precipitated with copper acetate, the latter filtered, washed and decomposed with hydrogen sulphide, again filtered and the filtrate evaporated in vacuum at a temperature of 40–45° and finally dried in vacuum over sulphuric acid. In appearance and reactions the acid was practically identical with phytic acid except that after boiling with dilute hydrochloric acid and neutralizing it slightly reduced Fehling's solution. This reduction, however, we believe to be due to admixed impurities; for, as stated above, the acid was not prepared from a pure compound.

The aqueous solution of the acid coagulates egg albumen at once. As has been already mentioned phytic acid gives the same reaction as well as the inosite esters of phosphoric and pyrophosphoric acids. Apparently, therefore, no special significance can be attached to this reaction.

The acid gave the following result on analysis after previously drying at 105° in vacuum over phosphorus pentoxide:

Found C = 11.71; H = 3.07; P = 26.35 per ct.

The crystalline precipitate mentioned on page 6, which separated from the solution of the first barium precipitate in 0.5 per ct. hydrochloric acid, was treated with about 5 per ct. hydrochloric acid in which the greater portion dissolved. The insoluble matter was removed by centrifuging and the solution precipitated with alcohol. This operation was repeated a second time when the substance was obtained nearly white. It differed from the first preparation in that its solution in dilute hydrochloric acid was neither mucilaginous nor opalescent. For further purification the substance was first precipitated by barium hydroxide from its dilute hydrochloric acid solution, and then twice precipitated from dilute hydrochloric acid with alcohol. The precipitates produced by the alcohol were amorphous at first but when allowed to stand over night in the mother liquor they always changed to the same crystalline form as previously mentioned.

After precipitating the last time with alcohol the substance was quickly filtered, washed in dilute alcohol, alcohol and ether and dried in vacuum over sulphuric acid. The product was a snow-white amorphous powder and it weighed 7.4 grams.

The filtrate from the above was allowed to stand over night when a small amount of the substance crystallized out. The crystals were filtered, washed in dilute alcohol, alcohol and ether and dried in the air. The substance was free from chlorine and gave no appreciable color reaction with phloroglucine or orcine. For analysis it was dried at 105° in vacuum over phosphorus pentoxide.

0.2450 gram subst. lost 0.0272 gm. H_2O on drying
0.2178 gram subst. gave 0.0284 gm. H_2O and 0.0522 gm. CO_2
0.1776 gram subst. gave 0.1170 gm. $BaSO_4$ and 0.1078 gm. $Mg_2P_2O_7$.

Found C = 6.53; H = 1.45; P = 16.91; Ba = 38.76; H_2O = 11.10 per ct.

This substance agrees nearly in composition with tribarium phytate. Calculated for tribarium phytate, $C_6H_{18}O_{27}P_6Ba_3 = 1120$.

C = 6.42; H = 1.60; P = 16.60; Ba = 36.78; $8H_2O$ = 11.39 per ct.

The amorphous product (7.4 grams) mentioned above was analyzed after previous drying at 105° in vacuum over phosphorus pentoxide and the following results obtained:

C = 8.04; H = 1.62; P = 16.65; Ba = 36.55 per ct.

The substance was free from chlorine. It was very slightly soluble in boiling water. With phloroglucine it gave a cherry red color; with orcine only a faintly, greenish color was produced. After boiling in dilute hydrochloric acid, precipitating the barium with sulphuric acid, filtering and neutralizing, it reduced Fehling's solution slightly on boiling. Evidently some carbohydrate was still present.

For further purification the substance was dissolved in 0.5 per ct. hydrochloric acid, filtered and alcohol added until a faint permanent turbidity remained. This was cleared up by the addition of a few drops of dilute hydrochloric acid and the solution allowed to stand at room temperature. The substance soon began to separate in the same crystalline form as before. After standing for two days the crystalline substance was filtered off, washed in water, alcohol and ether and dried in vacuum over sulphuric acid.

The mother liquor was diluted with more alcohol and allowed to stand as before when a further quantity of the same shaped crystals was obtained. After filtering, washing and drying as before these salts were analyzed after first drying at 105°.

Found, first crop of crystals:

C = 7.06; H = 1.53; P = 16.46; Ba = 38.16 per ct.

Found, second crop of crystals:

C = 7.47; H = 1.58; P = 16.46; Ba = 38.12 per ct.

In order to determine if further treatment would alter the composition the whole substance was digested in 50 per ct. acetic acid over night, filtered, washed in water, alcohol and ether and dried in the desiccator. It was then dissolved in 0.5 per ct. hydrochloric acid, filtered and the solution brought to crystallization by the careful addition of alcohol as before. The product finally obtained weighed 3.8 grams and it was a snow-white crystalline powder. For analysis it was dried at 105° in vacuum over phosphorus pentoxide. Found: C = 7.10; H = 1.52; P = 17.17; Ba = 38.11 per ct. As continued treatment did not alter the composition and as it separated in crystalline form it was undoubtedly a homogeneous compound.

The free acid prepared from this purified barium salt by the same method as before gave the following result on analysis after previous drying at 78° in vacuum over phosphorus pentoxide:

0.2626 gram subst. gave 0.0763 gm. H_2O and 0.1049 gm. CO_2
0.1733 gram subst. gave 0.1686 gm. $Mg_2\ P_2\ O_7$.
Found C = 10.89; H = 3.25; P = 27.11 per ct.
Calculated for phytic acid $C_6H_{24}O_{27}P_6 = 714$.
C = 10.08; H = 3.36; P = 26.05 per ct.

This acid gave the same reactions as previously described.

PREPARATION OF INOSITE FROM THE ABOVE BARIUM SALT.

Of the dry salt, 1.34 grams were heated in a sealed tube with 10 cc. 5/N sulphuric acid to 160° for about three hours. After precipitating with barium hydroxide, the inosite was isolated in the usual way and recrystallized from dilute alcohol with addition of ether. The product was obtained in colorless needles free from water of crystallization. The yield was 0.17 grams or about 77 per ct. of the theory. It gave the reaction of Scherer and melted at 221° (uncorrected). The air dried substance was analyzed:

Found C = 39.81; H = 6.96 per ct.

A further quantity of the barium salt was prepared by the following method, which was found to be much less laborious than that used at first. The cottonseed meal, 8 kilograms, was digested in 16 liters of 0.2 per ct. hydrochloric acid for about 5 hours. It was then pressed through cheesecloth and the extract filtered through absorbent cotton. The extract was precipitated with excess of barium hydroxide, allowed to settle and then centrifuged. The precipitate was digested in several liters of 0.5 per ct. hydrochloric acid and again centrifuged. The free acid was then nearly neutralized with barium hydroxide. The precipitate which separated was the barium salt of the organic phosphoric acid. This was filtered and treated with 0.5 per ct. hydrochloric acid, in which it was readily soluble at first, but it soon separated in the usual crystal aggregates. This was filtered and washed and dissolved in sufficient dilute hydrochloric acid and again filtered. The practically colorless filtrate was precipitated by alcohol. After filtering, it was again dissolved in dilute hydrochloric acid and precipitated with barium hydroxide, filtered and washed in water. It was then dissolved in dilute hydrochloric acid, precipitated with alcohol, filtered, washed in dilute alcohol, alcohol and ether and dried in vacuum over sulphuric acid. The product was a snow-white amorphous powder, and it weighed 24 grams. It was dissolved in about 300 cc. 0.5 per ct. hydrochloric acid filtered and allowed to stand a short time, when a portion crystallized out. This was filtered off, washed several times in water and finally in alcohol and ether, and dried in the air. The white crystalline powder weighed 7.4 grams. The filtrate and

washings from above were united and precipitated by alcohol. After standing over night the amorphous precipitate had changed to the usual crystalline form. After filtering, washing and drying in vacuum over sulphuric acid it weighed 14.7 grams.

The above salts were free from chlorine. The nitric acid solutions gave no immediate reaction with ammonium molybdate. No appreciable color reactions were obtained with phloroglucine or orcine and they did not reduce Fehling's solution. Metals other than barium were absent. For analysis the substances were dried at 105° in vacuum over phosphorus pentoxide.

The first crystalline compound gave the following: C = 6.05; H = 1.45; P = 16.51; Ba = 40.04; H_2O = 12.06 per ct. This salt is evidently a mixture of the tri- and tetrabarium salt. It was recrystallized as follows: One gram of the substance was dissolved in about 150 cc. of 0.5 per ct. hydrochloric acid and the free acid nearly neutralized with barium hydroxide. About 0.5 gram of barium chloride was then added and the solution allowed to stand for two days at room temperature. The substance separated slowly in the same general crystal form as before, except that the individual crystals were much larger. These were filtered, washed in water, alcohol and ether and dried in the air. Under the microscope the substance appeared homogeneous. Yield 0.9 grams. After drying at 105° in vacuum it was analyzed:

0.4067 grams subst. lost 0.0496 grams on drying.
0.3571 grams subst. gave 0.0358 grams H_2O and 0.0699 grams CO_2.
0.2068 grams subst. gave 0.1530 grams Ba SO_4 and 0.1160 grams $Mg_2P_2O_7$.

Found: C = 5.33; H = 1.12; P = 15.63; Ba = 43.53; H_2O = 12.19 per ct.

Calculated for tetrabarium phytate $C_6H_{16}O_{27}P_6Ba_4$ = 1255.
C = 5.73; H = 1.27; P = 14.82; Ba = 43.74; 10 H_2O = 12.54 per ct.

The second crystalline compound mentioned above gave the following result on analysis:
C = 6.88; H = 1.50; P = 15.94; Ba = 37.38 per ct.
P = 16.28; Ba = 37.21 per ct.

This corresponds to a tribarium salt.

A further quantity of the free acid was prepared from this salt by the usual method. From 7 grams of the substance practically the theoretical quantity of acid was obtained. After drying at 100° the substance was analyzed:

0.2319 grams subst. gave 0.0767 grams H_2O and 0.0925 grams CO_2.

After drying over boiling chloroform over phosphorus pentoxide:
0.2378 grams subst. gave 0.0703 grams H_2O and 0.0961 grams CO_2.
0.1495 grams subst. gave 0.1414 grams $Mg_2 P_2 O_7$.

Found C = 10.87; H = 3.70 per ct.
C = 11.02; H = 3.30; P = 26.36 per ct.

Calculated for phytic acid, $C_6H_{24}O_{27}P_6 = 714$.
$C = 10.08$; $H = 3.36$; $P = 26.05$ per ct.

This preparation gave the same reactions as those previously mentioned. When carefully prepared the acid is a thick colorless syrup readily soluble in water and alcohol. Attempts were made to prepare crystalline salts of the acid with organic bases like pyridine and brucine, but without success. These salts could not be obtained in crystalline form. In every case they separated as thick liquids, which could not be brought to crystallize even after long standing.

The reactions of the aqueous solution of the acid with inorganic bases may be briefly stated as follows:

It is not precipitated by chlorides of the alkaline earths, but acetates and hydroxides produce white amorphous precipitates. Ammonium molybdate gives a heavy white crystalline precipitate. Silver nitrate in excess produces a heavy white amorphous precipitate. Magnesia mixture also gives a voluminous white amorphous precipitate. While barium chloride does not give any precipitate, if the solution is allowed to stand at room temperature over night or longer the barium salt crystallizes out in delicate needle-shaped crystals. In shape and arrangement these crystals are identical with those previously referred to but they are much larger. It immediately coagulates egg albumen.

A neutral solution of the acid does not reduce Fehling's solution: even after boiling with dilute hydrochloric acid for some time no reduction takes place. No appreciable color reaction is given with phloroglucine or orcine.

Ferric chloride gives a white precipitate very sparingly soluble in hydrochloric acid. Copper acetate in excess gives a bluish-white precipitate.

On drying at 78° or 100° the substance turns very dark in color, but on drying at 60° the color changes but slightly. All the barium salts obtained were strongly acid in reaction on moist litmus paper.

It is evident that the substance isolated from cottonseed meal is very similar to phytin. The various salts which have been analyzed show but little difference in composition as compared with the corresponding phytin derivatives. It may be noted, however, that the analytical results of the purified, so-called, tri-barium salts point to the empirical formula $C_2 H_4 P_2 O_8 Ba$. Such a compound might be a monobasic acid of the formula $CH_3 PO_4$, but it is also isomeric with inosite hexaphosphate and accordingly differs very little in composition from phytic acid.

Whether the organic phosphoric acid in cottonseed meal is identical with phytin, an isomer, or is a somewhat differently constituted substance, can hardly be determined from the data presented in this paper. The investigation will be continued.

NOTE.—In describing the properties of the organic phosphoric acid of cottonseed meal, Technical Bulletin No. 25, the author regrets that, through oversight, he omitted to mention that some similar reactions had been reported by J. B. Rather, Bulletin 146, Texas Agricultural Experiment Station (1912), in his work on "The Forms of Phosphorus in Cottonseed Meal." This applies particularly to the reactions which formerly had been considered indicative of the presence of pyro- and metaphosphoric acids. In the above work Mr. Rather attributes these reactions to the compounds which he had isolated rather than to pyro- and metaphosphoric acids and states, p. 14, "It appears that, since the compounds described on the preceding pages have properties very similar to meta- and pyrophosphoric acids, conclusions that the latter are present in cottonseed meal have no value when based on these reactions."

REPORT

OF THE

Botanical Department.

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*Resigned before close of year.

REPORT OF THE BOTANICAL DEPARTMENT.

SEED TESTS MADE AT THE STATION DURING 1911.*

SUMMARY.

During 1911 there were received by the Station and tested for purity, 1015 samples of agricultural seeds: 548 of alfalfa, 253 of red clover, 98 of timothy, 86 of alsike clover, and 30 of miscellaneous plants. Dodder occurred in 12.9 per ct. of the alfalfa samples and in 4.74 per ct. of the red clover samples, a slightly larger percentage in each case than in 1910. Large-seeded dodder occurred in twice as many samples as did the small-seeded kind. Red clover and alsike clover contained rather more noxious weeds this year than last. Adulteration was found in two cases of red clover seed, and twelve of alsike clover. Yellow trefoil grows readily in alsike clover fields and our observations indicate that several cases of adulteration of alsike seed with yellow trefoil were due to the presence of yellow trefoil in the field. Many samples were altogether too small for dependable tests. *Centaurea repens* was found in several alfalfa seed samples,— an indication that the seed was imported. Russian thistle and roquette continue to attract attention in alfalfa fields but we have no evidence that indicates danger from these weeds in this State. Several failures in oat seedings were found to be due to sowing oats that had been bleached with sulphur fumes.

INTRODUCTION.

During the past year the Station has continued to make purity tests of agricultural seeds sent in by farmers and seedsmen of the State. In all, 1015 samples were tested during the calendar year 1911: 548 of alfalfa, 253 of red clover, 98 of timothy, 86 of alsike clover and 30 of miscellaneous seeds.

* A reprint of Bulletin No. 345, February, 1912; for "Popular Edition," see p. 820.

Frequent requests were made for germination tests, as was the case last year; but the Station has not, as yet, the facilities for making large numbers of such tests and we were unable to comply except in a few special cases. Germination tests are important, since the purchaser should know the viability of seed that he intends to sow, but the method of making these tests is so simple that any crop raiser can easily make them at home. Many of the samples received were too small for a reliable test and the writer takes this opportunity of again calling attention to the importance of sending samples that represent so far as possible the bulk of seed from which they are taken. We strongly urge that of alfalfa and clover, 2 ounces be sent for purity tests, and of grass seeds, 1 ounce. For a guide to the standards of purity and germination of seeds the reader is referred to the Yearbook of the U. S. Department of Agriculture for 1896 (p. 624), or to "complete" Bulletin No. 333 of this Station. The percentages there given have been carefully worked out and are recommended as a standard.

RESULTS OF ALFALFA SEED TESTS.

The analyses of the 548 alfalfa seed samples tested for purity this year indicate that such seed for sale in the State during the season of 1911 was, in general, good, high-grade seed. However, a few samples were received that contained several noxious weeds, a few that contained dodder, a few that contained too much dirt and chaff, and a few that were largely brown, shriveled and immature seed. It is evident, therefore, that the safest rule for the purchaser to follow is to buy seeds only by sample. This helps materially to insure a crop and reduces to a minimum the danger of introducing troublesome weeds.

Of the 548 samples tested, 71, or 12.9 per ct., contained dodder, 198, or 36 per ct. were less than 1 oz. in weight, 39, or 7 per ct., were below the average in general appearance, 76, or 13.8 per ct., contained a species of mustard (*Brassica* sp.), and 72, or 11 per ct., either because of color or because of the pres-

ence of *Centaurea repens,* were considered Turkestan alfalfa. There was no case of adulteration; that is, no sample contained 5 per ct. or more of any impurity. However, 91 samples contained sweet clover and in 7 of these it was present at the rate of 2 per ct.; five contained yellow trefoil in small amounts; and 23 samples contained a considerable amount of brown, shriveled alfalfa seed, most of which would not germinate. Samples like the last named show the importance and need of germination tests. Impure seed or seed of low viability is expensive at any price and should be avoided.

Dodder seed.— The amount of dodder seed found ranged from less than twenty seeds to the pound in 32 samples to 1,500 seeds in one sample, 2,000 in another and 2,800 in another, while 36 samples contained from 20 to 200 seeds. Two-thirds of the 71 dodder-infested samples contained the large-seeded kinds, about the same proportion as last year. Four samples contained both large and small-seeded dodder. Alfalfa seed containing dodder should be avoided. The small-seeded kind* may be removed by careful sifting; but this is impossible, so far as the writer is aware, in the case of the large-seeded kind.

Sweet clover.— Only 13 samples of alfalfa seed contained 1 per ct. or more of sweet clover seed, 7 samples showing from 1 to 2 per ct. and 6 samples from 2 to 3½ per ct. of this impurity.

General appearance.— Considering principally the characters of color, plumpness and size, and disregarding the impurities contained, 12 samples were graded as poor, 27 poor to average, 83 average, 96 average to excellent, and 330 excellent.

Weight of samples.— Many of the samples were too small to represent fairly the bulk of seed from which they were taken. Of those received during 1911, 80 samples weighed less than half an ounce, 63 one-half ounce, 55 three-fourths of an ounce, 75 one

* In this report "small-seeded" dodder seeds are such as will pass through a 20-mesh sieve made from No. 34 W. and M. steel wire. See Bulletin No. 305 of this Station. Seeds of the "large-seeded" dodder will not pass through such a sieve.

ounce, 75 one and one-half ounces and 200 samples two ounces or more. A purity test made from small samples can not be as reliable as a similar test made from larger samples.

Weed seeds found.— The following list shows the foreign seeds that occurred most frequently in the samples tested. In nearly all cases these seeds were present only in traces and the exact proportion was not determined.

NOXIOUS WEEDS.

English plantain (*Plantago lanceolata*)	occurred in 88 samples
Chicory (*Cichorium intybus*)	occurred in 66 samples
Dock (*Rumex* sp.)	occurred in 65 samples
Wild carrot (*Daucus carota*)	occurred in 33 samples

COMMON WEEDS.

Green foxtail (*Setaria viridis*)	occurred in 377 samples
Lamb's quarters (*Chenopodium album*)	occurred in 225 samples
Russian thistle (*Salsola kali* var. *tenuifolia*	occurred in 171 samples
Yellow foxtail (*Setaria glauca*)	occurred in 161 samples
Sweet clover (*Melilotus* sp.)	occurred in 91 samples
Brassica sp.	occurred in 76 samples
Atriplex sp.	occurred in 76 samples
Mallow (*Malva rotundifolia*)	occurred in 50 samples
Melilot (*Melilotus* sp.)	occurred in 51 samples
Centaurea repens	occurred in 52 samples
Timothy (*Phleum pratense*)	occurred in 49 samples
Catchfly (*Silene* sp.)	occurred in 20 samples
Alsike clover (*Trifolium hybridum*)	occurred in 14 samples
Roquette (*Eruca sativa*)	occurred in 33 samples
Johnson grass (*Sorghum halapense*)	occurred in 26 samples
Trianthema monogyna	occurred in 26 samples
Shaftal (*Trifolium suaveolens*)	occurred in 16 samples
Lance-leaved sage (*Salvia lanceaefolia*)	occurred in 10 samples
Barnyard grass (*Echinochloa crusgalli*)	occurred in 9 samples

RESULTS OF RED CLOVER SEED TESTS.

The 253 tests of red clover seed made during 1911 show that it maintains its bad reputation as to impurities, the seed this year falling below that of the previous year in purity. More samples contained noxious weeds in considerable quantities, more contained dodder, and two cases indicated adulteration. In general appearance the seed ranks well; for only 3 per ct. of the number tested were graded below average.

Weight of samples.— As with the alfalfa, many samples of red clover seed were too small in weight for satisfactory determin-

ations; 52 weighed less than half an ounce, 27 half an ounce, 37 three-fourths of an ounce, 31 one ounce, 21 one and one-half ounces and 85 two ounces or more.

General appearance.— Leaving impurities out of consideration and regarding principally color, size and plumpness, 4 samples were poor, 5 poor to average, 27 average, 26 average to excellent and 121 excellent.

Dodder.— Only 12 samples contained dodder — 5 large-seeded dodder only, 3 small-seeded only and 4 both kinds, the number of seeds to the pound ranging from 6 to 96 in 8 samples and from 272 to 2688 in the other 4 samples.

Adulterated samples.— Two samples of red clover were found to contain at least 5 per ct. of a single impurity and are therefore classed as adulterated. One sample contained 35 per ct. of alsike clover and 60 per ct. of yellow trefoil; and the other sample 5 per ct. of alsike clover.

Weed seeds found.— The following list gives the foreign seeds which occurred most frequently. The figures indicate the number of samples in which the given impurity occurred.

TABLE 1.— COMMON IMPURITIES OF RED CLOVER SEED.

Impurity.	Amount. Traces.	Amount. Considerable.	Total no. of samples.	Impurity.	Amount. Traces.	Amount. Considerable.	Total no. of samples.
English plantain.....	157	6	163	Lamb's quarters....	94	1	95
Curled dock........	146	1	147	Sheep sorrel........	90	6	96
Wild carrot........	20	...	20	Broad plantain	98	1	99
Canada thistle......	16	...	16	Ragweed	72	1	73
Chicory	6	...	6	Lady's thumb.......	65	...	65
Mustard (*Brassica* sp.)	12	...	12	Catchfly............	51	1	52
				Yellow foxtail......	27	...	27
Green foxtail	143	5	148	Pig-weed	24	...	24
Timothy	99	2	101	Crab-grass	23	1	24
Alsike clover.......	101	5	106	Yellow trefoil......	20	...	20

All the impurities in the following list were taken from one red clover sample, showing what may be expected in typical low-grade seed: Four per ct. of green foxtail, considerable crab grass, traces of English plantain, curled dock, ragweed, Canada

thistle, broad-leaved plantain, lamb's quarters, lady's thumb, yellow foxtail, mustard and alsike clover, as well as quite a little brown, shriveled clover seed, most of which would not germinate. The sample graded poor in general appearance.

RESULTS OF ALSIKE CLOVER SEED TESTS.

The 86 alsike clover tests seem to indicate that there was more impure alsike seed on the market during 1911 than in 1910. Several samples contained a considerable amount of noxious weed seed and 13 of the samples were adulterated. In general appearance the alsike seed seemed to be, in most cases, bright and plump, and only 14 per ct. was marked as falling below average. No dodder was found in any of the samples.

Adulterated samples.— Thirteen samples were adulterated, four with 6 or 7 per ct. of timothy and one with 35 per ct. of the same seed, one with 15 per ct. of sorrel, one with 9 per ct. of white clover, another with 6 per ct. of red clover, one with 6 per ct. of catchfly, and four with from 5 to 17 per ct. of yellow trefoil.

TABLE II.— FOREIGN SEEDS FOUND MOST FREQUENTLY IN ALSIKE CLOVER SAMPLES.

Impurity.	Amount. Traces.	Amount. Considerable.	Impurity.	Amount. Traces.	Amount. Considerable.
Sorrel	49	1	Green foxtail	22	...
Timothy	54	9	Lamb's quarters	17	...
Trefoil	46	14	Broad plantain	12	...
Dock	38	...	Pig-weed	3	...
Catchfly	33	4	Wild carrot	2	...
Canada thistle	29	...	Lady's thumb	1	...
English plantain	27	...	Ox-eye daisy	1	4

In general appearance two samples were poor, 11 poor to average, 13 average, 7 average to excellent and 53 excellent.

Weight of samples.— Low weight of samples again hindered, as 22 samples weighed less than half an ounce, 14 one-half ounce, 4 three-fourths ounce, 10 one ounce, 13 one and one-half ounces and 22 two ounces or more.

RESULTS OF TIMOTHY SEED TESTS.

The timothy seed examined during 1911 indicates that this seed is seldom low-grade as far as purity is concerned, being quite free from noxious weeds and inert matter. Alsike clover and broad-leaved plantain are the impurities most frequently found. One sample contained 15 per ct. of alsike clover.

General appearance.— From color, size and plumpness 1 sample was graded as poor, 4 poor to average, 11 average, 1 average to excellent, and 81 excellent.

Weight of samples.— Of the 98 samples 36 weighed less than one-half ounce, 12 one-half ounce, 9 three-quarters ounce and 41 one ounce or more.

TABLE III.— WEED SEED OCCURRING MOST FREQUENTLY IN TIMOTHY SEED SAMPLES.

Impurity.	Amount. Traces.	Amount. Considerable.	Impurity.	Amount. Traces.	Amount. Considerable.
Alsike clover	67	4	Catchfly	7	...
Broad plantain	65	...	Chickweed	6	...
Pepper grass	40	1	Mayweed	6	...
Lamb's quarters	40	...	White clover	4	1
Evening primrose	37	...	Ox-eye daisy	3	...
Sorrel	29	1	Crab-grass	4	...
Cinquefoil	28	...	Canada thistle	3	...
Yellow daisy	21	...	*Brassica* sp.	2	...
English plantain	12	...			

MISCELLANEOUS SAMPLES TESTED.

There were 30 miscellaneous samples tested during 1911 as follows:

	Samples.		Samples.
White clover	4	Kentucky blue grass	2
Red top	5	Corn, oats, cabbage, lawn grass mixtures	7
German millet	2		
Crimson clover	8		

No case of adulteration or misbranding was found in any of these miscellaneous samples.

GERMINATION TESTS.

In order to get some idea of the percentage of viable seeds in samples sent to this laboratory during 1911, a comparatively small number of samples were tested in the Geneva seed tester. In considering the results secured it will be well to bear in mind the U. S. Department of Agriculture germination standards, which are, for the sorts tested: Alfalfa, red clover and timothy, 85–90 per ct. viable; alsike clover, 75–80 per ct. viable.

VIABILITY OF ALFALFA SEED SAMPLES.

In the case of alfalfa, ten high grade samples and ten poor samples were selected for tests. The appearance of the seed was used as the basis for the selection of these samples, the amount of impurities present being disregarded.

Ten high grade samples.— In all of these tests duplicate sets of 100 seeds each were used and the duration of the test was seven days.

The average percentage of germination (not including hard seeds) was	81.9
The average percentage (including ⅓ of hard seeds) was	87½
The lowest percentage (hard seeds not viable)	56.5
The lowest percentage (⅓ hard seeds viable)	73.
The highest percentage (hard seeds not viable)	92.
The highest percentage (⅓ hard seeds viable)	94.

One sample contained 52½ per ct. of hard seeds at the end of the 7 day test. It is generally conceded that one-third of all leguminous seeds which remain hard during a test should be considered as viable. In that case the viability of this sample would be 73 instead of 56½. In order to test this point the hard seeds of the above sample were placed in moist petri dishes; at the end of two months rather more than one-third of them had germinated. The germination, however, was slow and not vigorous. The use of seed which showed so many hard seeds is not advisable.

Ten low-grade samples.— These samples were selected because of the presence of brown and shriveled alfalfa seed. The dura-

tion of the test was six days. One hundred seeds in duplicate were used in each test, thus making a total of 2,000 seeds. The average germination, not including hard seeds, was 71.8 per ct. Counting one-third of the hard seeds as viable, the average was 74.6 per ct.

The lowest percentage (hard seeds not viable)	33.
The lowest percentage (⅓ hard seeds viable)	33.
The highest percentage (hard seeds not viable)	88½
The highest percentage (⅓ hard seeds viable)	90½

VIABILITY OF RED CLOVER SEED SAMPLES.

Ten samples of red clover seed selected because their general appearance was "average or better" were tested in the same manner as were the alfalfa samples for their viability.

The average percentage of germination (not including hard seeds)	92.1
The average percentage of germination (including ⅓ of hard seeds as viable)	93.5
The lowest germination for any one sample (not including hard seeds)	84½
The lowest germination (including ⅓ of hard seeds as viable)	87½
The highest (not including hard seeds)	97½
The highest (including ⅓ hard seeds)	97½

The largest number of hard seeds found in any one sample was 16.

VIABILITY OF ALSIKE CLOVER SEED SAMPLES.

Ten samples of alsike clover were selected and tested as were the red clover seed samples.

The average percentage of germination (not including ⅓ of hard seeds)	80.1
The average percentage (including ⅓ of hard seeds)	84.2
Including ⅓ of hard seeds as viable, the lowest percentage of viability was	72½
Including ⅓ of hard seeds as viable, the highest percentage of viability was	92½

The largest number of hard seeds found in any one sample was 23.

The duration of test was 8 days.

VIABILITY OF TIMOTHY SEED SAMPLES.

Ten timothy seed samples were selected and tested for germination, as were the red clover and alsike seed samples.

The average percentage of viability was..........................	88.4
The lowest percentage of viability was..........................	70.
The highest percentage of viability was..........................	97.

NOTES ON ADULTERATED SAMPLES.

It appears from the evidence that has come to our attention during the past year that adulteration with yellow trefoil occurs in two ways: by willful addition of this seed to higher priced clover seed or by natural infestation in the field. A sample of seed bought for red clover and sent in to this Station during March, 1911, was found to contain 60 per ct. of yellow trefoil and 35 per ct. alsike clover. After receiving our report the dealer informed us that there was about 4 quarts of the trefoil in the center of each of the bags. This dealer stated that the one of whom he bought the seed did not know of its presence and the matter was dropped. This seems to be a clear case of willful adulteration.

A sample of alsike clover which had been grown in the vicinity of Fayette, N. Y., was brought in and found to contain 5 per ct. of trefoil seed. In this locality some of the alsike clover fields were badly infested with yellow trefoil and this case of adulteration was undoubtedly a result of natural infestation.

Another case of adulteration due to natural infestation was brought to our notice in April. This was a sample of alsike clover which contained 17 per ct. of yellow trefoil. The man who grew this seed knew that it contained the foreign seed of yellowish color but was not aware of its nature or source. He had offered it for sale but upon learning the exact situation he was very anxious to know of some method of separating the impurity.

It seems probable that the original introduction of yellow trefoil into the localities where this natural infestation occurred was by means of adulterated clover seed. If the land where this infestation occurred is as badly overrun with this weed as we have been led to believe, it is probable that the production of clean

alsike clover seed will be impossible until the infested fields have grown other crops which will tend to free the soil of the trefoil seed. Farmers who meet with such an experience will undoubtedly see the wisdom of sowing pure seed.

MISCELLANEOUS WEEDS AND SEEDS.

RUSSIAN THISTLE.

(*Salsola kali* var. *tenuifolia*)

This seed continues to occur in many alfalfa seed samples and the plant has been sent in to us for identification from several sources, but it always appears during the first year after seeding and no trouble from it in alfalfa fields after the first season has been called to our attention. We do not, therefore, consider it a bad weed.

ROQUETTE.

(*Eruca sativa*)

Roquette, like Russian thistle, has been found in alfalfa samples and has caused much anxiety to alfalfa growers because of its rank growth in newly seeded fields. In all cases so far reported to us nothing is seen of this plant after the first year and it is evidently not to be feared in alfalfa fields of this State.

JOHNSON GRASS.

(*Sorghum halapense*)

The seeds of this grass have been found in a number of alfalfa samples this year. Though this plant has not been established in New York State, it is such a troublesome weed in the South that attention is called to it at this time. Any information on the behavior of Johnson grass in New York State will be appreciated by this Station. Johnson grass frequently occurs in alfalfa as a naked kernel or caryopsis; the outer seed coverings or glumes being removed by the cleaning processes. The viability of some seeds would be destroyed by this treatment but our tests show that

a large percentage of these naked Johnson grass seeds will produce vigorous sprouts. It is possible, therefore, that this plant may become established in New York State by means of alfalfa seed containing it.

NEW SEEDS RECENTLY OBSERVED IN ALFALFA SEED.

In making our seed tests we occasionally meet with foreign seeds which are new to us and which we are unable to identify. These seeds most frequently occur in seed that has been imported into the United States from foreign countries. Seeds of this kind more often occur in alfalfa seed, and during the past year several such seeds unknown to us have been recorded in alfalfa seed samples. Such seeds may prove to be troublesome weeds when once established in this State and it is, therefore, important to learn their nature and habits at the outset so that if they prove to belong to the noxious class, farmers may be warned against them. For these reasons, attention is called to the following three plants, the seeds of which we have observed and recorded for the first time as occurring in alfalfa seed. The writer is indebted to Miss Emma Sirrine of the United States Department of Agriculture for the identification of these seeds and to Dr. N. L. Britton of the New York Botanical Garden for the identification of plants of *Trianthema monogyna* which were grown in the Station green house from seed collected in alfalfa samples sent to us for analysis.

Trianthema monogyna L.

The seeds of this plant were observed in 26 different alfalfa samples. It is a low-growing, procumbent, somewhat succulent herb, the general appearance of which suggests the common garden purslane. It belongs to the family Aizoaceae which is closely related to the Portulacaceae, the family to which purslane belongs. The genus *Trianthema* is chiefly made up of tropical or sub-tropical herbs; *T. monogyna* being the only American species. Dr. Britton informs us that he is quite familiar with it as a weed in

the West Indies. In the "Synoptical Flora of North America"* it is reported as occurring from the Keys of Florida to Arizona and on ballast in the Middle Atlantic States, in Mexico and in Lower California. Although we are certain that seeds of this plant have been sown with alfalfa seed, no specimens of it have been sent in for identification and we know nothing about its behavior in New York State.

SHAFTAL.

(*Trifolium suaveolens* Willd.)

This plant belongs to the clover family, is a vigorous grower but is not likely to develop into a troublesome pest. Mr. Brandt† says of it: "Shaftal, which is an annual plant, is the chief fodder crop in the valleys of the northwest frontier of India. It is always grown with irrigation and gives exceedingly good yields." The seed of this plant occurred in 16 samples of alfalfa seed, but was present only in small quantities.

LANCE-LEAVED SAGE.

(*Salvia lanceaefolia* Poir.)

Lance-leaved sage has occurred previous to 1911 in alfalfa samples but we were not able to learn its name until this year. Its seed was found in ten alfalfa samples and it never occurred more than in traces. We have not been able to learn the nature of this plant in alfalfa fields, but it is an annual and not likely to be troublesome. Robinson and Fernald‡ give its range as, "Plains and open soil Ind. to Neb. Tex. and Ariz.; introduced at Columbus, O." No plants of it have been sent to us for identification.

SULPHURED OR BLEACHED OATS.

During the past year we have had several samples of oats sent in for germination tests. Growers who had sown seed from lots which these samples represented found that only a few seeds

* "Synoptical Flora of North America" Vol. 1, part 1, p. 259. The older name of this plant is here given as *T. portulacastrum* L.

† U. S. Dept. Agr. Bur. Plant Indus. Bul. 162:67.

‡ Gray's New Manual of Botany. Seventh Ed. p. 703.

sprouted. This had resulted in an entire failure of the crops and we were asked to determine the cause.

In all of the samples, the seed was unusually light colored, bright, smooth, and vigorous in appearance. The very light color led us to suspect that it had been treated with sulphur fumes. This process is apparently quite frequently used in the West to improve the appearance of seed that has become moldy or dull looking and has been reported by several of the eastern experiment stations as one which has resulted in severe losses to oat crops. Samples of bleached oats were sent in to this Station for the first time during 1911.

If properly carried out, the bleaching process does not materially injure the viability of the seed, but if the seed is allowed to remain in the fumes for any great length of time much damage results and such seed is absolutely worthless for seeding purposes. It is said, however, that seed so treated does not lose its nutritive value and is not injurious to animals. Chemical tests of four samples made by Mr. A. W. Bosworth, Associate Chemist of this Station, showed that sulphuric acid was present in large quantities. Germination tests of the same samples show the following percentages of viable seed:

Sample No. 1	14 per ct. viable
Sample No. 2	1 per ct. viable
Sample No. 3	none viable
Sample No. 4	none viable

For detailed information concerning the bleaching of oats and barley seed with sulphur fumes and a method for detecting seed that has been so treated, the reader is referred to two publications of the United States Department of Agriculture: Bureau of Plant Industry Circulars No. 40, W. P. Carroll, "A Simple Method of Detecting Sulphured Barley and Oats," and No. 74, Le Roy M. Smith, "The Sulphur Bleaching of Commercial Oats and Barley."

A COMPARATIVE TEST OF LIME-SULPHUR, LEAD BENZOATE AND BORDEAUX MIXTURE FOR SPRAYING POTATOES.*

F. C. STEWART AND G. T. FRENCH.

SUMMARY.

This bulletin contains an account of an experiment designed to test the relative merits of lime-sulphur (1 to 40), lead benzoate (1 lb. to 50 gals.) and bordeaux mixture (6-6-50) for spraying potatoes. The experiment included 20 rows of potatoes, 412 ft. long. Each of the three spray mixtures was applied six times (at intervals of two weeks) to five rows and the remaining five rows served as checks. "Bugs" were eliminated by making two applications of lead arsenate over the whole field. The spraying was done very thoroughly.

There was no late blight, very few flea beetles and a very little early blight, in October. Tip burn was the only disease of consequence.

In October the bordeaux rows were strikingly superior to all others. They were larger, freer from tip burn and lived longer. The lead benzoate rows were equal to the checks. The lime-sulphur rows were plainly smaller than the checks and as badly affected with tip burn. None of the mixtures burned the foliage.

The bordeaux rows yielded 100.3 bu. per acre more than the checks, lead benzoate 6 bu. less than the checks, and lime-sulphur 39.5 bu. less than the checks.

The results indicate plainly that neither lead benzoate nor lime-sulphur can be profitably substituted for bordeaux mixture in spraying potatoes. Both lack the stimulative influence possessed by bordeaux while lime-sulphur also dwarfs the plants and lowers the yield.

INTRODUCTION.

Within the past few years the lime-sulphur solution has largely superseded bordeaux mixture as a summer spray for apple scab. While probably as efficient as bordeaux in the control of scab it is less liable to burn the foliage and russet the fruit. Many fruit

* A reprint of Bulletin No. 347, March, 1912; for "Popular Edition," see p. 830.

growers are using it, also, as a fungicide on the foliage of pears, plums, currants and gooseberries.

With the rise in popularity of lime-sulphur as an orchard spray there has arisen the question as to its value in the potato field; that is to say, How does it compare with bordeaux as a spray for potatoes? For orchardists who also grow potatoes it would be convenient to use in the potato field the same spray mixture that they use in their orchards. Besides, when used at a dilution of 1 to 40, lime-sulphur is somewhat cheaper than bordeaux.

Some potato growers have already used lime-sulphur extensively during the past two or three years and a few have experimented with it more or less; but, as yet, few, if any, carefully conducted experiments with lime-sulphur on potatoes have been reported. Clinton states[1] that, in Connecticut, in a season when there was but little blight, commercial lime-sulphur did not prolong the life of the vines or give increased yield while bordeaux mixture did both. In the Vermont experiment conducted by Jones and Giddings[2] the self-boiled lime-sulphur (Scott's mixture) was used instead of the concentrated lime-sulphur solution with which we are dealing here.

Lead benzoate was included in the experiment because a manufacturer of this substance claims that it possesses marked fungicidal properties.

PLAN OF THE EXPERIMENT.

Including an outside row and a row which fell in a dead-furrow (Row 13) there were 22 rows of potatoes in the experiment. The rows were 412 x 3 ft., 35.24 rows being required to make an acre. Adjoining the experiment field on the west was another potato field which made an outside row on that side unnecessary.

Rows 2, 6, 10, 15 and 19 were sprayed with bordeaux.

Rows 3, 7, 11, 16 and 20 were sprayed with lead benzoate.

Rows 4, 8, 12, 17 and 21 were sprayed with lime-sulphur.

Rows, 1, 5, 9, 14 and 18 were used for checks.

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1 Clinton, G. P. Report of the Station Botanist 1909–1910. Conn. Sta. Rpt. 1909–1910, Part 10:743. 1911.

2 Jones, L. R., and Giddings, N. J. Vt. Sta. Bul. 142:112–114. 1909.

SOIL AND CULTURAL CONDITIONS.

The soil was heavy clay loam plowed in the fall and again in the spring. The previous crop was a light one of peas and oats. The field sloped toward the north sufficiently to afford excellent surface drainage. Planting was done May 22 and 23, the seed being of the variety Rural New Yorker No. 2. Furrows were opened with a plow and the seed pieces dropped by hand 15 inches apart the distance being determined by a gauge-rod marked at intervals of 15 inches. Each row received 14 pounds (500 lbs. per acre) of a complete chemical fertilizer which was scattered in the open furrow by hand as uniformly as possible. With the exception of one light hoeing the cultivation was all done with a horse cultivator.

PREPARATION AND APPLICATION OF SPRAY MIXTURES.

The bordeaux mixture used contained six pounds of copper sulphate and six pounds of unslaked lime in each fifty gallons (6-6-50 formula).

The concentrated lime-sulphur solution used was taken from two different lots which had been prepared for use in the Station orchard. Both lots were made by the Geneva Station formula:

Lime (90 per ct. pure)	40 lbs.
Sulphur (high grade, finely divided)	80 lbs.
Water	50 gals.

One lot had a density of 23° B. the other, 24° B.

Both were diluted at the rate of two gallons of the concentrated solution to fifty gallons of water. This is approximately the dilution recommended for orchard spraying, namely, 1 to 40 when the density of the concentrated solution is 32° B.

The lead benzoate used was in the form of a white paste which, according to the manufacturer, was 65¼ per ct. water. Three pounds of this paste (= 1 + lbs. dry lead benzoate) were first thoroughly stirred into about two gallons of hot water and afterward diluted to fifty gallons.

Each of the three spray mixtures was applied six times. The first application was made on July 7 when the plants were six to eight inches high and the others followed at intervals of two weeks. For the control of Colorado potato beetles or "bugs" arsenate of lead was used with all of the spray mixtures in the first two applications at the rate of three pounds to fifty gallons. On the same dates the check rows were treated with three pounds of arsenate of lead in fifty gallons of water.[1]

All of the spraying was done very thoroughly with a knapsack sprayer which was used also for applying arsenate of lead to the check rows. In the last two applications, when the plants were full grown, the spray mixtures were applied at the rate of about 200 gallons per acre.

EFFECT ON THE FOLIAGE.

For about seven weeks following planting the weather was very dry and the potatoes made a slow, spindling growth. Later, rain was more abundant and the plants improved so much that during August and the fore part of September the whole field looked well, although the plants were somewhat smaller than usual for this time of year. Late blight (*Phytophthora infestans*) was entirely absent. Early blight (*Alternaria solani*) appeared only to a slight extent, in October. There were very few flea beetles. "Bugs" were kept under control so that they were not a factor in the results. The only disease of any consequence affecting the plants was a form of tip burn (a browning of the tips of the leaves) which appeared about September 10 and gradually increased in prevalence until all rows, excepting those sprayed with bordeaux, were killed by it. For some unknown reason this tip burn appeared earlier and was more destructive in the north than in the south half of the field. Its exact nature is unknown to the writers. But for the fact that the bordeaux rows were nearly free from it until after about October 10 it would have

[1] Check Row 1 was treated with paris green (1 lb. to 50 gals.) instead of arsenate of lead. This was necessary because this row served also as a check in another experiment in which paris green was used on the checks.

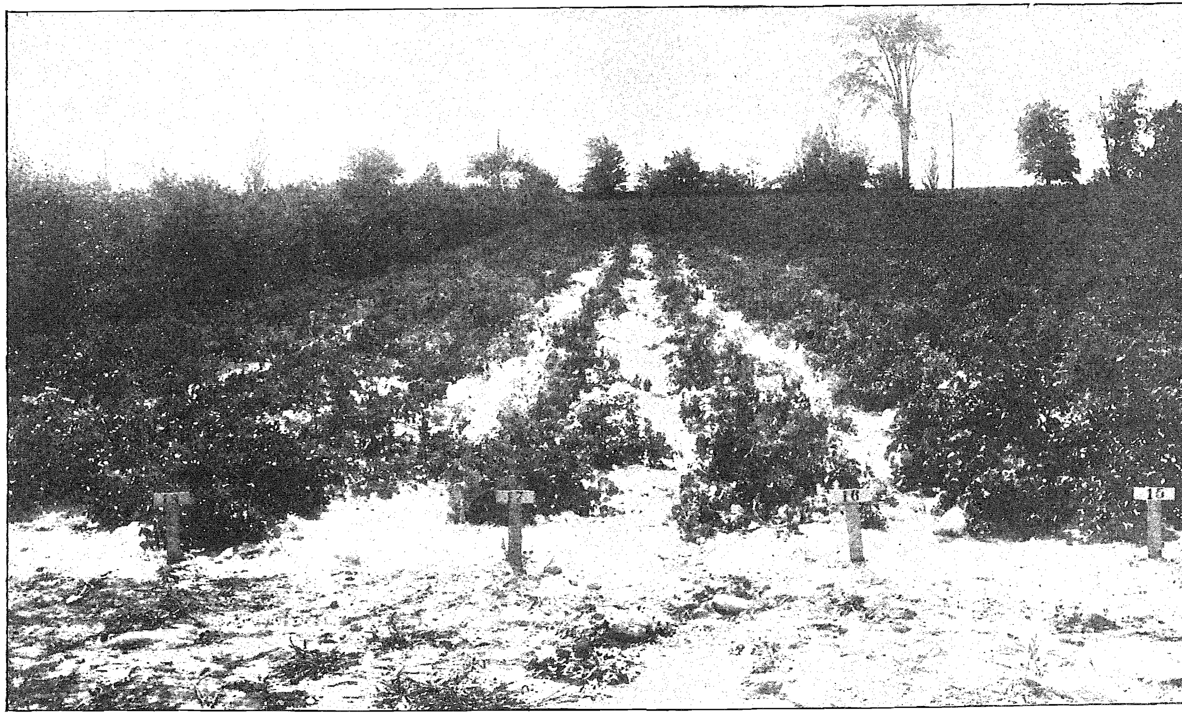

PLATE II.— NORTH END OF EXPERIMENT FIELD ON SEPTEMBER 28.

Row 15 (bordeaux) in full foliage; Rows 16 (lead benzoate), 17 (lime-sulphur) and 18 (check) nearly dead.

(Bare ground whitened with air-slaked lime.)

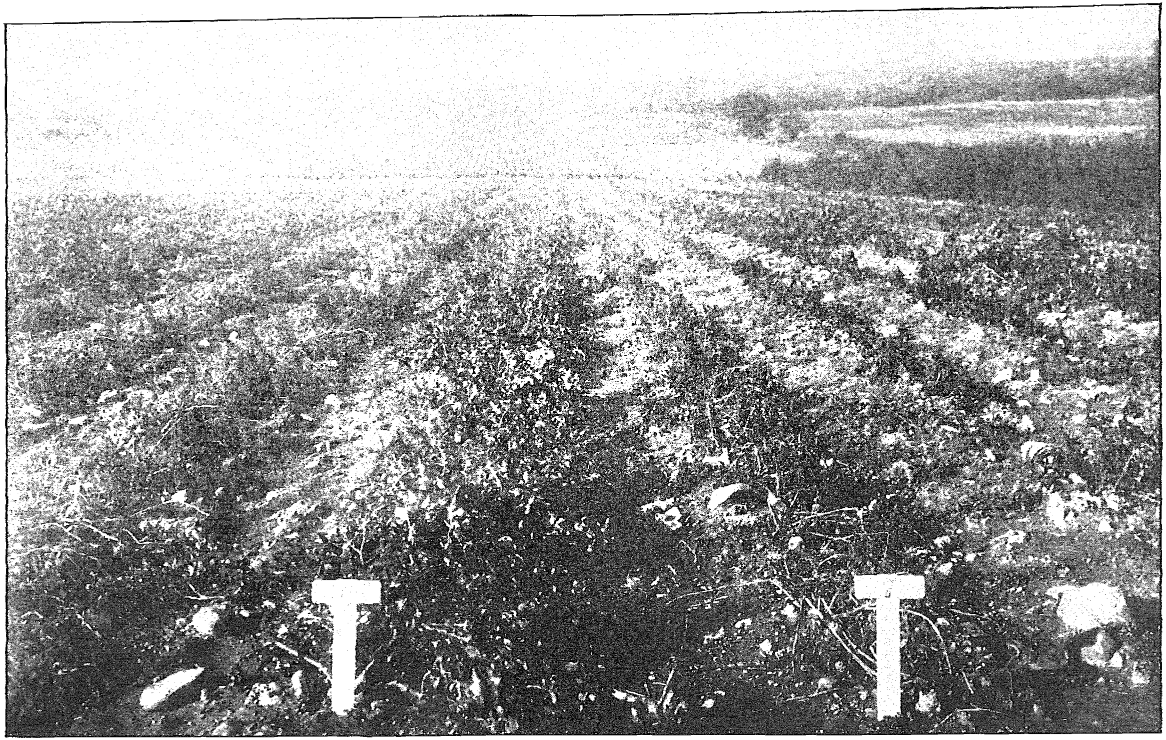

Plate III.— Near South End of Experiment Field on October 23.
Row 6 (bordeaux) in full foliage; Row 7 (lead benzoate) entirely dead.

Plate IV.— Near South End of Experiment Field on October 23.
Rows 8 (lime-sulphur) and 9 (check) entirely dead.

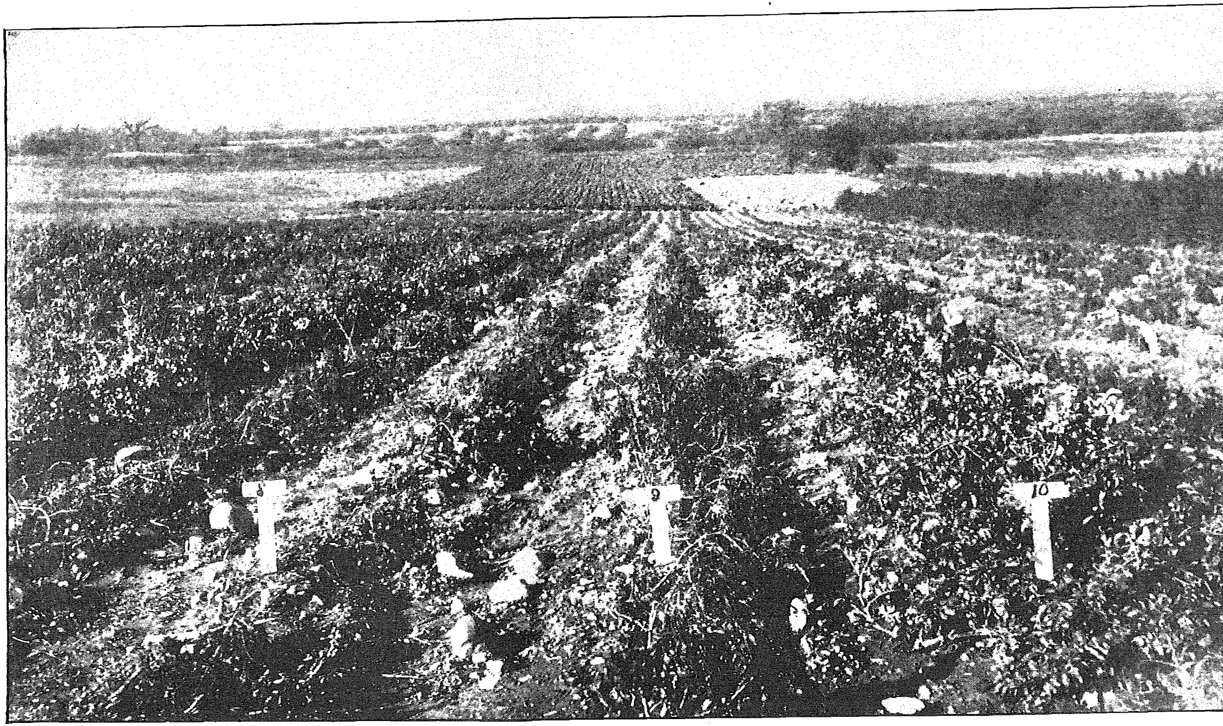

Plate V.— Near South End of Experiment Field on October 23.

Rows 8 (lime-sulphur) and 9 (check) dead; Row 10 (bordeaux) in full foliage. Showing smaller size of plants on Row 8.

passed for the natural breaking down of the tissues due to age. Such it may have been. It seems improbable that it could have been due to heat and drought (commonly held to be the cause of tip burn) because it did not appear until long after the hot, dry weather had passed. Neither is there any evidence that it was due to a parasitic organism. So far as could be determined none of the spray mixtures burned the foliage at any time and none of the injury can be attributed to that cause.

Notwithstanding the scarcity of fungus and insect enemies the beneficial influence of the bordeaux mixture began to be manifest about the middle of September and, ultimately, became very marked. Plants sprayed with bordeaux appeared larger than the checks, were much freer from tip burn and lived longer. On the other hand, lead benzoate had no influence either way while lime-sulphur proved positively harmful. Lime-sulphur had a dwarfing effect. Plants sprayed with it were considerably smaller than check plants. How early this appeared we do not know. It was first recognized on September 16. Even at that time it was quite evident, but became more noticeable in October. That the lime-sulphur plants were actually smaller than the check plants there can be no doubt. Their stalks were shorter and of smaller diameter. Whether the leaves, also, were of smaller average size could not well be determined, owing to the numerous blemishes caused by tip burn.[1]

The lead benzoate, lime-sulphur and check rows appeared to be equally affected by tip burn and died at the same time. They died at the north (lower) end of the field between two and three

[1] Lime-sulphur may slightly affect apple foliage in a similar manner. Dr. H. S. Reed (*The Country Gentleman* 77:7, Jan. 27, 1912) says: "In the spring when the leaves of certain varieties [of apple] are tender they may be dwarfed by the spray. This is usually done by application before the trees bloom. Lime-sulphur is especially likely to cause this dwarfing of the leaves." In the spring of 1910 Mr. P. J. Parrott, Entomologist of this Station, called our attention to a pronounced dwarfing of early-formed apple leaves due to the use of lime-sulphur (1 to 40) in the Station orchard. The dwarfed leaves showed no lesions of any kind. They had not been burned by the spray. The damage done must have been very small.

Hartzell (N. Y. [State] Sta. Bul. 331:580) has described a dwarfing of grape berries which he attributes to lime-sulphur with which the grapes had been sprayed.

weeks earlier than at the south (upper) end. The gradual decline and death of the plants progressed steadily from the north toward the south end of the field. From about October 1 to October 27 the bordeaux rows were very conspicuous because of their superior condition. The first killing frost occurred during the night of October 27. At this time the bordeaux rows were still quite green throughout the south half of their length and dead throughout the north half. All other rows had been entirely dead for more than a week.

EFFECT ON THE YIELD.

At digging time the product of each row was carefully sorted and weighed separately. No rotten tubers were found. The yield by rows was as follows:

TABLE I.— YIELDS IN POTATO SPRAYING EXPERIMENT.

Row.	Treatment.	Yield per row.*		Yield per acre. (Computed).	
		Marketable tubers.	Small tubers.	Marketable tubers.	Small tubers.
		Lbs.	*Lbs.*	*Bu.*	*Bu.*
1	Check	353	9.5	207.3	5.6
2	Bordeaux	488.5	9.5	286.9	5.6
3	Lead benzoate	321	13.5	188.5	7.9
4	Lime-sulphur	266	12	156.2	7
5	Check	323.5	9	190	5.3
6	Bordeaux	481	8	282.5	4.7
7	Lead benzoate	323	9	189.7	5.3
8	Lime-sulphur	245	10	143.9	5.9
9	Check	291	11	170.9	6.4
10	Bordeaux	486	9.5	285.4	5.6
11	Lead benzoate	249	11	146.2	6.4
12	Lime-sulphur	246.5	11	144.7	6.4
13	Dead-furrow	Yield not taken.			
14	Check	265.5	15.5	155.9	9
15	Bordeaux	477	12	280.1	7
16	Lead benzoate	286.5	15	168.2	8.8
17	Lime-sulphur	195	15	114.5	8.8
18	Check	263	15	154.4	8.8
19	Bordeaux	417	11	244.9	6.4
20	Lead benzoate	266	12	156.2	7
21	Lime-sulphur	207	14	121.5	8.2

* Rows 412 × 3 ft. 35.24 rows = 1 acre.

Average yield of check rows	175.7 bu. per acre.[1]
Average yield of bordeaux rows......	276 bu. per acre.
Average yield of lead benzoate rows..	169.7 bu. per acre.
Average yield of lime-sulphur rows..	136.2 bu. per acre.
Gain from use of bordeaux	100.3 bu. per acre.
Loss from use of lead benzoate	6 bu. per acre.
Loss from use of lime-sulphur	39.5 bu. per acre.

At the time of the second spraying, check rows 1 and 5 were sprayed with bordeaux by mistake. Because of this it is probable that their yield is slightly greater than it should be and it may well be argued that the first two sections (Rows 1 to 8) of the experiment should be rejected. However, to do so would not alter the figures materially. If we take into consideration only the last three sections (Rows 9 to 21) the results are as follows:

Gain from use of bordeaux...........	109.7 bu. per acre.
Loss from use of lead benzoate.......	3.5 bu. per acre.
Loss from use of lime-sulphur........	35.5 bu. per acre.

The difference between bordeaux and lime-sulphur is slightly greater by the second than by the first method of calculation.

Considering the dwarfed condition of the plants on the lime-sulphur rows it is not strange that these rows gave a lower yield than the check rows. On the other hand, the difference in yield between lead benzoate and check rows is probably small enough to come within the limit of experimental error. In the absence of any apparent difference in foliage this small difference in yield should not be accepted as conclusive evidence that the influence of the lead benzoate was harmful.

On the bordeaux rows the tubers were of very large average size. Many of them were so large that, probably, they could not have been sold for full market price.

CONCLUSION.

The results of this experiment are so striking that but one conclusion can be drawn, viz., that neither lead benzoate nor lime-

[1] Marketable tubers.

sulphur can be profitably substituted for bordeaux mixture in the spraying of potatoes. Both lack the stimulative influence[1] possessed by bordeaux and, besides, lime-sulphur has a tendency to dwarf the plants and lower the yield. However, it will be necessary to repeat this experiment several times before the relative efficiency of the different spray mixtures can be definitely stated. The differences obtained in this experiment are undoubtedly extreme.

Under other conditions the results might have been very different. The unusually long growing season (158 days) gave the bordeaux an opportunity to exert its influence to the full extent. Had the plants been killed by frost about October 1, as frequently happens, the differences in yield would have been much smaller. Also, had the spraying been less thorough there would have been less benefit from the bordeaux and less injury from the lime-sulphur. In light applications, such as are commonly made by farmers who use horse-power sprayers, the injurious effect of the lime-sulphur would probably not be great enough to attract attention. Had there been a severe attack of blight the results might have been different. The value of lead benzoate and lime-sulphur for the prevention of potato blight is yet unknown, but it is improbable that either is superior to bordeaux mixture for this purpose.

POSTSCRIPT.—Since this bulletin was written we find in the Journal of the Department of Agriculture and Technical Instruction for Ireland (Vol. XII, No. 2, Jan., 1912), an account of an experiment made by Dr. Pethybridge in Ireland. In this experiment three applications of lime-sulphur solution (dilution not stated) proved utterly useless as a preventive of blight (*Phytophthora infestans*).

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[1] Although unable to explain the process, physiologically, the writers are confident that bordeaux preserves the foliage, prolongs the life and increases the yield of potato plants *even in the absence of parasitic organisms*. The experiment reported in this bulletin is only one of several in which we have observed what we consider evidence of the stimulative influence of bordeaux. While this view is held by many experimenters there are some who dispute it. (See article by O. Kirchner in *Ztschr. Pflanzenkr.* 18:65–81. 1908.)

LIME-SULPHUR vs. BORDEAUX MIXTURE AS A SPRAY FOR POTATOES, II. *

M. T. MUNN.

SUMMARY.

The experiment herein described is, in the main, a repetition of an experiment made in 1911. The results of the 1912 experiment agree essentially with those obtained in 1911. Plainly, the lime-sulphur solution is not to be recommended as a spray for potatoes. Six applications of bordeaux mixture prolonged the life of the plants about two weeks and increased the yield of marketable tubers at the rate of 111.5 bu. per acre; while rows receiving six applications of lime-sulphur died earlier, even, than the check rows.

Tipburn, and late blight (*Phytophthora infestans*) associated with and following which is the common rot of the potato tubers, were the chief diseases encountered in the experiment. Both were largely controlled by bordeaux. Lime-sulphur, on the contrary, dwarfed the plants and aggravated the tipburn, although, so far as could be determined, it did not burn the foliage. The effect of lime-sulphur on late blight and rot (*Phytophthora infestans*) is uncertain, but, apparently, it did not check them.

INTRODUCTION.

During the year 1911 an experiment designed to test the relative merits of lime-sulphur, lead benzoate, and bordeaux mixture, as a spray for potatoes, was conducted; and a detailed report upon it was given by F. C. Stewart and G. T. French in Bulletin No. 347 of this Station. It was deemed advisable to repeat this experiment during the past season along similar lines, but to omit the use of lead benzoate as it was conclusively shown that this material possessed no merits as a spray for potatoes.

* A reprint of Bulletin No. 352, November, 1912; for "Popular Edition," see p. 850.

OUTLINE OF EXPERIMENT.

PLAN.

The experiment field consisted of an area 212 x 51 feet which allowed 17 rows, each 212 feet long and 3 feet wide, each row thus containing approximately one sixty-ninth of an acre. After excluding a row on each side of the field as an outside row, there remained 5 series of rows with 3 rows in each series. Row No. 1 of each series was sprayed with bordeaux mixture, Row No. 2 with lime-sulphur and Row No. 3 was retained as a check. By this arrangement Rows 1, 4, 7, 10 and 13 were sprayed with bordeaux mixture, Rows 2, 5, 8, 11 and 14, with lime-sulphur, and Rows 3, 6, 9, 12 and 15 were not sprayed.

CULTURE OF CROP.

The slope of the field was sufficient to afford good surface drainage. The soil was a heavy clay loam. The field produced a crop of wheat the previous year and was plowed in the spring. Before planting, the area was harrowed twice. Seed of the variety Sir Walter Raleigh was planted by hand on May 24. Furrows were opened with a plow and the seed pieces placed 15 inches apart by the use of a gauge-rod. No fertilizer of any kind was applied at the time of planting. A horse cultivator was used during the season to keep the soil in good tilth. In addition to this, one light hoeing was given during the early summer. The cultivation, as a whole, was such as would be given a potato field on any well regulated farm.

PREPARATION OF THE SPRAY MIXTURES.

The concentrated lime-sulphur solution used was taken from a stock prepared for use in the station orchards, according to the Geneva Station Formula:

Lime (95 per ct. pure)	38 lbs.
Sulphur (high grade, finely divided)	80 lbs.
Water	50 gal.

This concentrate tested 24° Beaumé, and in order to reduce this mixture to the strength recommended for orchard spraying (1

to 40 when the density of the concentrate is 32° Beaumé), it was diluted at the rate of two gallons of the concentrate to fifty gallons of water.

The bordeaux mixture used was prepared from stock solutions and according to the 6–4–50 formula, thereby containing six pounds of copper sulphate and four pounds of unslaked lime in each fifty gallons.

The arsenate of lead used for the control of bugs was in the form of a thick paste and was used at the rate of three pounds to fifty gallons of the spray mixture, or to fifty gallons of water in the case of the check rows.

TIME AND NUMBER OF APPLICATIONS.

On July 9, when the plants were about six to eight inches high, the first application of the two sprays was given. This was repeated every two weeks until the vines were entirely dead. Six applications in all were made during the season.

In order to control the Colorado potato beetles or "bugs," arsenate of lead, at the rate of three pounds to fifty gallons of the spray mixture, was added and applied with the first two sprayings. On these same dates the check rows were sprayed with three pounds of arsenate of lead in fifty gallons of water. Following the first spraying it was found that the bugs were not as efficiently controlled on the lime-sulphur rows as they were on the other rows. The cause of this is uncertain, but was perhaps due to a lack of care in mixing the lime-sulphur and arsenate of lead. In order to control the bugs it was necessary to spray the entire field again in two days with three pounds of arsenate of lead in fifty gallons of water. This spraying and the addition of poison in the next regular spraying completely controlled the bugs for the entire season, and the use of a poison was thereafter discontinued.

Both of the spray mixtures were applied with a knapsack sprayer, which permitted a very thorough spraying in every case. The rate of application varied from 150 to 200 gallons per acre, depending upon the size of the plants, and the season.

RESULTS.

EFFECT OF THE SPRAYS ON THE FOLIAGE.

In addition to the desirability of testing the value of lime-sulphur as compared with bordeaux as a preventive of potato blight (*Phytophthora infestans*) it was one of the objects of this experiment to determine the effect of the two preparations on the foliage. At short intervals during the season notes were taken upon the condition of the foliage in the experimental field. The weather following planting was such as to induce a satisfactory growth, and at the end of the sixth week the plants were about eight inches high, in full foliage, even all over the field, and growing vigorously. At this time, July 9, the first application of the spray mixtures was given. Previous to the third spraying all the rows looked very uniform in size and color of foliage, but on August 6, following the third spraying, more yellow and dead leaves were noticed on the lower branches of the plants in the lime-sulphur rows and the check rows, than on the bordeaux rows, which, with the exception of an occasional dead leaf, were entirely free and presented a vigorous appearance. Flea-beetle injury, while very slight, was more prevalent on the lime-sulphur and check rows than on the bordeaux rows, no doubt due to the deterrent properties of the bordeaux. About August 16 tipburn appeared and continued to increase gradually in extent upon the lime-sulphur rows and the checks until the end of the season. The bordeaux rows were nearly free from it during the entire season while on the lime-sulphur rows it appeared as if the trouble was aggravated by the lime-sulphur spray. A large percentage of the plants in the lime-sulphur rows were completely dead from the effects of the tipburn several days before many plants had died in the check rows. It cannot be stated that this trouble called tipburn was due to insufficient moisture owing to the fact that it appeared more destructive in the latter part of the season and at a time when rains were frequent, often preventing cultivation for several days. It also appeared more destructive on the north half of the field which was slightly lower than the south half of the field.

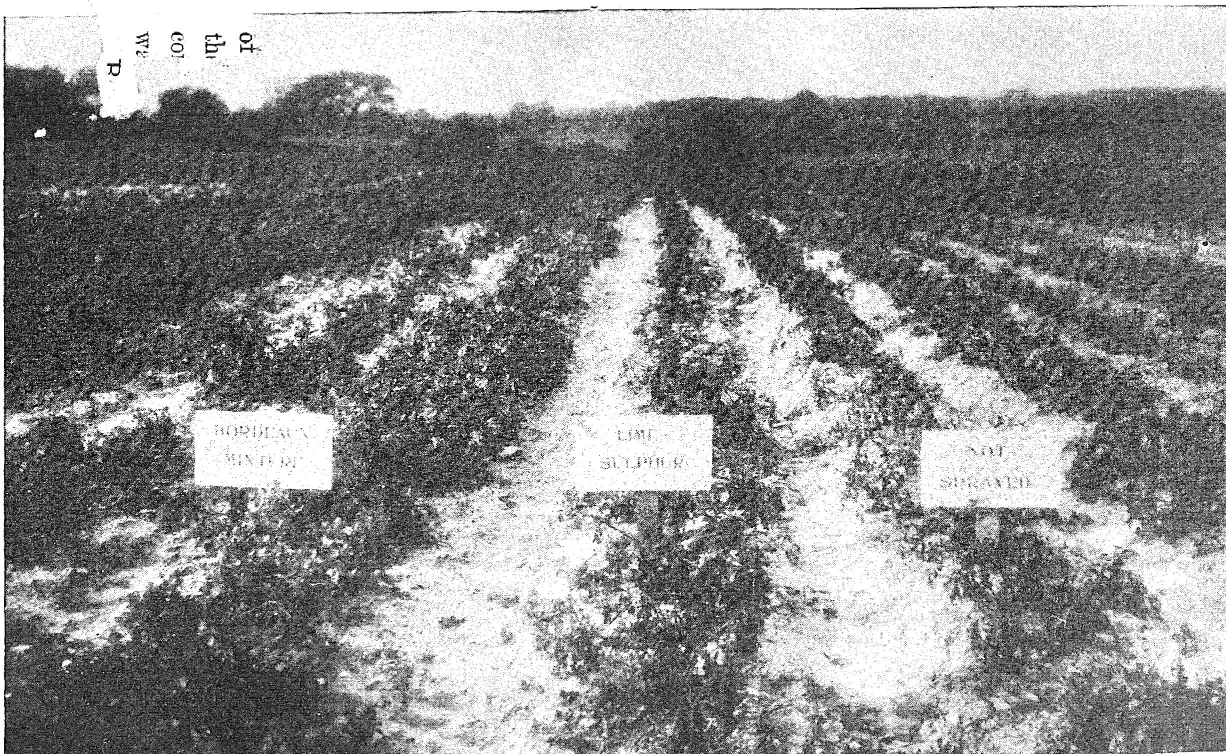


PLATE VI.—VIEW FROM SOUTH END OF EXPERIMENTAL FIELD ON SEPTEMBER 27.
Bordeaux rows in full foliage; lime-sulphur rows entirely dead; check rows nearly dead.

On August 20, attention was attracted to the slightly smaller size of plants in the lime-sulphur rows as compared with those in the bordeaux rows and the checks. This difference became quite marked on August 25 when it could be plainly seen that the plants in the lime-sulphur rows were smaller in size, not as spreading or bushy, and the stems appeared smaller, when compared with plants in the other rows. This difference was noticeable throughout the remainder of the season.

On September 3, late blight (*Phytophthora infestans*), which caused much tuber rot later in the season, was found to be prevalent in a nearby potato field, but it did not appear in the experimental field until September 25 when it was found on the check rows upon a number of living plants that still remained in those rows, and also upon the few living plants that still remained in the lime-sulphur rows. The number of living plants was considerably smaller in the lime-sulphur rows than in the check rows. All of the plants then alive in both rows were soon killed by the combined attack of the tipburn and the blight.

The late appearance of the Phytophthora blight in the field was perhaps due to the somewhat small growth of potato foliage caused by a lack of fertility in the soil. In nearby potato fields the foliage blight was prevalent and followed by a severe rotting of the potato tubers. A very little early blight (*Macrosporium solani*) occurred in September.

The superior condition of the bordeaux rows first became apparent about August 20 and the difference became conspicuous during the latter part of the season. On October 17, the date upon which they were harvested, the bordeaux rows still contained several living plants. They outlived the lime-sulphur and check rows over two weeks.

YIELDS.

The following table shows the kind of treatment, also the yield as determined by carefully sorting and weighing each row separately at the time of digging.

TABLE I.— COMPARATIVE YIELDS OF POTATOES SPRAYED WITH LIME-SULPHUR AND BORDEAUX MIXTURE.

Row No.	Kind of treatment.	Yield per row.			Computed yield per acre.			
		Marketable tubers.	Small tubers.	Rotten tubers.	Marketable tubers.	Small tubers.	Rotten tubers.	Total yield.
		Lbs.	*Lbs.*	*Lbs.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
1	Bordeaux.......	217.5	10.0	1.0	246.6	11.4	1.1	259.1
2	Lime-sulphur....	148.0	17.0	9.0	168.9	19.4	10.2	198.5
3	Check..........	137.5	10.0	64.5	156.9	11.4	73.9	242.2
4	Bordeaux.......	283.5	9.0	8.0	323.6	10.2	9.1	342.9
5	Lime-sulphur....	154.0	5.5	44.5	175.8	6.2	50.8	232.8
6	Check..........	163.5	7.0	86.0	186.6	7.9	98.1	292.6
7	Bordeaux.......	276.0	5.0	6.0	315.1	5.7	6.9	327.7
8	Lime-sulphur....	166.0	5.5	16.5	189.5	6.2	18.8	214.5
9	Check..........	134.5	6.0	88.0	153.5	6.9	100.4	260.8
10	Bordeaux.......	236.0	4.0	5.0	269.4	4.5	5.7	279.6
11	Lime-sulphur....	152.0	5.5	18.0	173.5	6.2	20.5	200.2
12	Check..........	148.5	5.0	51.5	169.5	5.7	58.7	233.9
13	Bordeaux.......	200.0	6.0	0.0	228.3	6.9	0.0	235.2
14	Lime-sulphur....	131.0	10.0	1.0	149.5	11.4	1.1	162.0
15	Check..........	140.0	9.0	4.0	159.0	10.2	4.5	173.7

TABLE II.— SUMMARIZED YIELDS OF POTATOES SPRAYED WITH LIME-SULPHUR AND BORDEAUX MIXTURE.

Kind of treatment.	Average yield per acre.			
	Marketable tubers.	Small tubers.	Rotten tubers.	Total.
	Bu.	*Bu.*	*Bu.*	*Bu.*
Bordeaux mixture........................	276.6	7.7	4.5	288.8
Lime-sulphur............................	171.4	9.8	20.3	201.5
Check...................................	165.1	8.4	67.1	240.6

Gain from use of bordeaux 111.5 bu. marketable tubers per acre.
Gain from use of lime-sulphur, 6.3 bu. marketable tubers per acre.
Gain from use of bordeaux, 48.2 bu. in total yield per acre.
Loss from use of lime-sulphur, 39.1 bu. in total yield per acre.

Although showing a considerably smaller total yield, the lime-sulphur rows gave a slightly larger yield of marketable tubers than did the check rows. This is due to the smaller loss from rot on the lime-sulphur rows. This was only 20.3 bushels as

against 67.1 bushels per acre on the check rows. One unfamiliar with the experiment might draw the conclusion that lime-sulphur has some value as a preventive of tuber rot. However, the facts in the case do not warrant such a conclusion. The correct interpretation seems to be as follows: There was less tuber rot on the lime-sulphur rows because at the time blight attacked the field there were fewer live plants on these rows. Many were already dead and incapable of taking blight, consequently they were incapable of transmitting the disease to the tubers. On the check rows there were more living plants for the disease to attack. Such plants as were still alive on the lime-sulphur rows seemed to be quite as severely attacked as those on check rows, but the data on this point are insufficient for definite conclusions.

It is also worthy of note that all the rotten tubers on the bordeaux rows were found in a slight depression at the north end of the field, where the surface water from rains flowed across the rows and undoubtedly carried spores from the adjoining infected rows. No blight was found upon plants in the bordeaux rows at any time during the season.

There was a marked difference in the size of the tubers from the rows under different kinds of treatment. Tubers from the bordeaux rows were somewhat larger than those from the check rows and considerably larger than those from the lime-sulphur rows.

It is not strange that the lime-sulphur rows gave a lower yield than the check rows when one considers the dwarfed condition of the plants in those rows and the fact that a great many of the plants were dead several days before those in the check rows.

Although blight did not appear until late in the season after a large percentage of the plants had died, so that the amount of foliage affected was not large, the severity of the tuber rot is surprising. It is evident that under favorable weather conditions a small amount of blight may cause a heavy loss from tuber rot.

CONCLUSIONS.

The information at hand is quite sufficient as a basis for some final conclusions. It seems evident that lime-sulphur is not destined to take the place of bordeaux mixture as a spray for potatoes, in spite of the fact that it is cheaper and no doubt very convenient to use. Under more favorable conditions, in which late blight occurred earlier in the season and to a greater extent, the treatment with lime-sulphur might have produced different results, but at present it is not promising. However, the experiments have not been carried far enough to determine what may be expected under favorable conditions.

The lime-sulphur proved harmless to the potato foliage as far as burning is concerned, but it proved to have a distinct dwarfing effect quite similar to that noted in the previous season's experiment. The lime-sulphur also lacked the beneficial or stimulative effect derived from the bordeaux mixture which preserved the foliage and prolonged the life of the plants and thereby increased the yield even in the partial absence of fungus diseases.

It could not be determined at just what time in the season or after which application the dwarfing effect of the lime-sulphur first occurred, but it was first noticeable on August 20 at the time of the fourth spraying, and on August 25 following this spraying it became quite marked. It therefore appears that the injury is cumulative. The benefical effect of the bordeaux on the foliage was observed on August 6 or approximately two weeks before the injurious effect of the lime-sulphur was noticed, when it was plainly evident that there were many yellow and dead leaves on the lower branches of plants in the lime-sulphur rows and in the check rows while there were practically none on the bordeaux rows which held their foliage throughout the season.

In general, then, we are led to the same conclusions published in last year's bulletin on a similar experiment, namely, that spraying potatoes with bordeaux mixture increases the yield of tubers and prolongs the life of the plants; while the use of lime-sulphur dwarfs the plants, causes them to die earlier, and causes an appreciable loss in yield. Certain it is that spraying potatoes with bordeaux mixture should not be omitted by the potato grower.

POTATO SPRAYING EXPERIMENTS, 1902-1911.*

F. C. STEWART, G. T. FRENCH AND F. A. SIRRINE

SUMMARY.

This bulletin gives a detailed account of the potato spraying experiments conducted by the Station in 1911 and a summary of results obtained in similar experiments made during the nine years preceding.

In the so-called ten-year experiments the ten-year average increase in yield is as follows:

At Geneva, three sprayings, 69 bu. per acre.

At Geneva, five to seven sprayings, 97.5 bu. per acre.

At Riverhead, three sprayings, 25 bu. per acre.

At Riverhead, five to seven sprayings, 45.7 bu. per acre.

In the farmers' business experiments (6 to 15 each year) the nine-year averages are as follows:

Increase in yield, 36.1 bu. per acre.

Total expense of spraying, $4.74 per acre.

Net profit from spraying, $14.43 per acre.

In 205 volunteer experiments, covering seven years, the average increase in yield was 54.3 bu. per acre.

These experiments demonstrate, beyond doubt, that the spraying of potatoes is highly profitable in New York.

Spraying with bordeaux mixture should be commenced when the plants are six to eight inches high and repeated at intervals of 10 to 14 days throughout the season, making five to seven applications in all. Some poison should be added to the bordeaux whenever bugs or flea beetles are plentiful. The spraying should be very thorough — the more thorough the better.

INTRODUCTION.

Does it pay to spray potatoes in New York? Potato growers have long asked this question. It is well known that in seasons

* A reprint of Bulletin No. 349, June, 1912; for "Popular Edition," see p. 831.

when blight is destructive spraying will check the blight and considerably increase the yield; but the majority of potato growers have doubted that spraying is profitable on the average. They argue that blight does not appear every year. In some seasons it causes but little if any damage, yet the spraying must be done regularly because it is impossible to foretell the appearance of blight. The result is that in some seasons spraying is profitable while in others it is unprofitable and growers doubt that the aggregate gain will repay the expense of spraying for a series of years.

The Station set out to find an answer to the above question. The investigation was begun in 1902 and concluded in 1911. During ten consecutive years several potato spraying experiments have been made each year. These experiments are of three kinds: (1) Station ten-year experiments (two each year), carried out entirely by the Station; (2) farmers' business experiments (12 to 15 each year), conducted by farmers in coöperation with the Station; (3) farmers' volunteer experiments carried out entirely by farmers. This bulletin gives details of the experiments made in 1911 and a summary of the results obtained in the previous nine years.

Bulletins of this series previously published are:

No. 221. Potato Spraying Experiments in 1902;
No. 241. Potato Spraying Experiments in 1903;
No. 264. Potato Spraying Experiments in 1904;
No. 279. Potato Spraying Experiments in 1905;
No. 290. Potato Spraying Experiments in 1906;
No. 307. Potato Spraying Experiments in 1907;
No. 311. Potato Spraying Experiments in 1908;
No. 323. Potato Spraying Experiments in 1909;
No. 338. Potato Spraying Experiments in 1910.

SUMMARY OF RESULTS OBTAINED IN TEN-YEAR EXPERIMENTS PRIOR TO 1911.

RESULTS IN 1902.

Table I.— Yield by Series at Geneva in 1902.

Series.	Rows.*	Dates of spraying.	Yield per acre.†	
			Bu.	*lbs.*
I......	1, 4, 7 and 13.......	July 10, 23 and Aug. 12.....................	317	41
II......	2, 5, 8 and 14.......	June 25, July 10, 23, 30, Aug. 12, 26 and Sept. 10....................................	342	36
III......	3, 6, 9 and 15.......	Not sprayed.............................	219	4

* Rows 10, 11 and 12 omitted because of probable error.
† The yields given in Tables I to XVIII relate to marketable tubers only.

Increase in yield due to spraying three times, 98½ bu. per acre.
Increase in yield due to spraying seven times, 123½ bu. per acre.

The unsprayed rows died two weeks earlier than the sprayed rows, owing chiefly to a severe attack of late blight. They were also somewhat injured by flea beetles, but there was no early blight. On unsprayed rows the loss from rot was 7½ per ct.; on sprayed rows only an occasional tuber.

Table II.— Yield by Series at Riverhead in 1902.

Series	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	2, 5, 8 and 11.......	May 26, June 20 and July 12...............	295	20
II......	1, 4, 7 and 10.......	May 26, June 3, 20, 30, July 11, 23 and Aug. 5.	312	35
III......	3, 6, 9 and 12.......	Not sprayed.............................	267	40

Increase in yield due to spraying three times, 27⅗ bu. per acre.
Increase in yield due to spraying seven times, 45 bu. per acre.

In this experiment there were only traces of early blight and no late blight. The larger yield on sprayed rows was due to partial protection against flea beetles which were rather plentiful at times. There was no rot.

RESULTS IN 1903.

Table III.— Yield by Series at Geneva in 1903.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 14, 28 and Aug. 26....................	262	—
II......	2, 5, 8, 11 and 14....	July 7, 21, Aug. 7, 21 and Sept. 3...........	292	10
III......	3, 6, 9, 12 and 15....	Not sprayed..............................	174	20

Increase in yield due to spraying three times, 88 *bu. per acre.*
Increase in yield due to spraying five times, 118 *bu. per acre.*

Three sprayings prolonged the life of the plants 11 days; five sprayings, 18 days. There was no early blight and the injury from flea beetles was only slight. Late blight was again the chief enemy. The loss from rot was even less than in 1902.

Table IV.— Yield by Series at Riverhead in 1903.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7 and 10.......	June 5, July 22 and Aug. 7.................	246	45
II......	2, 5, 8 and 11.......	June 5, 24, July 7, 22 and Aug. 7............	263	10
III......	3, 6, 9 and 12.......	Not sprayed..............................	207	10

Increase in yield due to spraying three times, 39½ *bu. per acre.*
Increase in yield due to spraying five times, 56 *bu. per acre.*

The sprayed rows outlived those unsprayed by several days. Late blight and flea beetles were the chief enemies. Early blight, also, caused slight damage. On the unsprayed rows the loss from rot was 2 per ct.; on those sprayed, practically nothing.

RESULTS IN 1904.

TABLE V.—YIELD BY SERIES AT GENEVA IN 1904.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 13, 27 and Aug. 15....................	344	30
II......	2, 5, 8, 11 and 14....	July 8, 22 and Aug. 1, 15 and 29...........	386	40
III......	3, 6, 9, 12 and 15....	Not sprayed............................	153	25

Increase in yield due to spraying three times, 191 bu. per acre.
Increase in yield due to spraying five times, 233 bu. per acre.

Spraying prolonged the life of the plants 25 days. Late blight was the only trouble. On both sprayed and unsprayed rows there was a little rot at digging time. In storage, the sprayed potatoes rotted most. Spraying materially improved the cooking qualities.

TABLE VI.—YIELD BY SERIES AT RIVERHEAD IN 1904.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7 and 10.......	June 14, July 21 and Aug. 9................	257	58
II......	2, 5, 8 and 11.......	June 14, 27, July 11, 26, Aug. 9 and 22.......	297	45
III......	3, 6, 9 and 12.......	Not sprayed............................	201	25

Increase in yield due to spraying three times, 56½ bu. per acre.
Increase in yield due to spraying six times, 96⅓ bu. per acre.

The larger yield on sprayed rows was due chiefly to partial protection against flea beetles which were unusually abundant. Both early and late blight were also present. The loss from rot was 3 per ct. on Series I, 1 per ct. on Series II, and 6 per ct. on Series III.

RESULTS IN 1905.

TABLE VII.— YIELD BY SERIES AT GENEVA IN 1905.

Series.	Rows.*	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	4, 7, 10 and 13......	July 3, Aug. 7 and 25......................	228	45
II......	5, 8, 11 and 14......	June 29, July 13, 27, Aug. 12 and 24.........	241	15
III......	6, 9, 12 and 15......	Not sprayed............................	121	52

* Rows 1, 2 and 3 omitted because of error.

Increase in yield due to spraying three times, 107 *bu. per acre.*
Increase in yield due to spraying five times, 119⅓ *bu. per acre.*

From the combined attack of flea beetles, tip burn and late blight the unsprayed rows died fully two weeks earlier than the sprayed ones. Spraying reduced the loss from rot at the rate of 41 bushels per acre. There was no subsequent rot in storage.

TABLE VIII.— YIELD BY SERIES AT RIVERHEAD IN 1905.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	June 14, July 18 and Aug. 11...............	253	—
II......	2, 5, 8, 11 and 14....	June 14, 30, July 14, 28 and Aug. 11.........	303	41
III......	3, 6, 9, 12 and 15....	Not sprayed............................	221	38

Increase in yield due to spraying three times, 31⅓ *bu. per acre.*
Increase in yield due to spraying five times, 82 *bu. per acre.*

Late blight caused no injury in this experiment and there was not even a trace of rot. Flea beetles and early blight were the enemies fought.

RESULTS IN 1906.

TABLE IX.— YIELD BY SERIES AT GENEVA IN 1906.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 9, Aug. 10 and 30.....................	227	25
II......	2, 5, 8, 11 and 14....	July 6, 20, Aug. 6, 20 and 21...............	258	40
III......	3, 6, 9, 12 and 15....	Not sprayed............................	195	40

Increase in yield due to spraying three times, 31¾ bu. per acre.
Increase in yield due to spraying five times, 63 bu. per acre.

Late blight, early blight, flea beetles and tip burn were all factors in this experiment, but none of them caused much damage. Spraying controlled blight and flea beetles completely and tip burn partially. The loss from rot was negligible, only four rotten tubers being found in the entire experiment.

TABLE X.— YIELD BY SERIES AT RIVERHEAD IN 1906.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	June 12, July 18 and Aug. 6................	172	—
II......	2, 5, 8, 11 and 14....	June 12, 25, July 10, 25 and Aug. 6..........	203	45
III......	3, 6, 9, 12 and 15....	Not sprayed............................	150	30

Increase in yield due to spraying three times, 21½ bu. per acre.
Increase in yield due to spraying five times, 53¼ bu. per acre.

In the experiment at Riverhead the principal enemies were late blight and flea beetles, there being a moderate attack of both. Early blight was not sufficiently abundant to cause material injury. There was no loss from rot.

RESULTS IN 1907.

TABLE XI.— YIELD BY SERIES AT GENEVA IN 1907.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 15, Aug. 9 and 24....................	220	15
II......	2, 5, 8, 11 and 14....	July 15, 24, Aug. 9, 24 and Sept. 17.........	249	50
III......	3, 6, 9, 12 and 15....	Not sprayed..............................	176	10

Increase in yield due to spraying three times, 44 *bu. per acre.*
Increase in yield due to spraying five times, 73⅔ *bu. per acre.*

Late blight and rot were wholly absent and early blight appeared only in traces. There was some tip burn and a light attack of flea beetles. Considering the seemingly small amount of damage done by blight and insects it is remarkable that spraying should have increased the yield so much.

TABLE XII.— YIELD BY SERIES AT RIVERHEAD IN 1907.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	June 19, July 25 and Aug. 15...............	186	45
II......	2, 5, 8, 11 and 14....	June 19, July 2, 17, 31, Aug. 15 and 29.......	200	5
III......	3, 6, 9, 12 and 15....	Not sprayed..............................	168	50

Increase in yield due to spraying three times, 18 *bu. per acre.*
Increase in yield due to spraying six times, 31¼ *bu. per acre.*

There was some early blight, but no late blight. Flea beetles were plentiful and caused much damage. The larger yield of the sprayed rows is to be attributed to their partial protection against flea beetles and early blight.

RESULTS IN 1908.

TABLE XIII.— YIELD BY SERIES AT GENEVA IN 1908.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 3, 17 and Aug. 3......................	155	40
II......	2, 5, 8, 11 and 14....	July 3, 17, Aug. 3, 18, Sept. 1, and 16........	165	10
III......	3, 6, 9, 12 and 15....	Not sprayed..............................	126	10

Increase in yield due to spraying three times, 29½ bu. per acre.
Increase in yield due to spraying six times, 39 bu. per acre.

There was no early blight, no late blight and no rot. Flea beetles caused slight damage to the unsprayed rows, most of which occurred after September 1st. The chief trouble was tip burn, which was quite severe. The sprayed rows of Series II outlived the unsprayed rows of Series III by about five days owing, apparently, to the smaller amount of tip burn and flea beetle injury on the sprayed rows.

TABLE XIV.— YIELD BY SERIES AT RIVERHEAD IN 1908.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	June 11, July 9 and Aug. 4..................	147	35
II......	2, 5, 8, 11 and 14....	June 11, 25, July 9, 24 and Aug. 4...........	152	10
III......	3, 6, 9, 12 and 15....	Not sprayed..............................	136	50

Increase in yield due to spraying three times, 10¾ bu. per acre.
Increase in yield due to spraying five times, 15⅓ bu. per acre.

In this experiment there was some early blight and a moderate attack of flea beetles, but no late blight and no rot. During July considerable damage was done by aphids which were not checked by the spraying.

RESULTS IN 1909.

TABLE XV.— YIELD BY SERIES AT GENEVA IN 1909.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 9, 23 and Aug. 11....................	162	20
II......	2, 5, 8, 11 and 14....	July 9, 23, Aug. 11, 27, Sept. 10 and 24......	173	25
III......	3, 6, 9, 12 and 15....	Not sprayed............................	123	40

Increase in yield due to spraying three times, 38⅔ bu. per acre.
Increase in yield due to spraying six times, 49¾ bu. per acre.

Early blight, late blight and rot were all absent. Some injury from flea beetles was noticeable throughout the season. After September 1 there was considerable tip burn. As late as September 24 the difference between sprayed and unsprayed rows appeared slight. The sprayed rows held most of their foliage until killed by frost on October 14.

TABLE XVI.— YIELD BY SERIES AT RIVERHEAD IN 1909.

Series.	Rows.	Dates of spraying.	Yield per acre.*	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	June 11, July 16 and 31....................	136	30
II......	2, 5, 8, 11 and 14....	June 11, 25, July 9, 24, Aug. 6, and 21.......	160	20
III......	3, 6, 9, 12 and 15....	Not sprayed............................	107	50

* Marketable tubers only. Owing to their small average size it was deemed advisable to make two grades of the marketable tubers; " firsts " which sold for 80 cents per bushel and " seconds " which sold for 40 cents. The increase in yield due to spraying was chiefly in the grade of " firsts," the yields being as follows:
Rows sprayed three times, 75⅓ bu. " firsts " and 61⅙ bu. " seconds; " rows sprayed six times, 100 bu. " firsts " and 60⅓ bu. " seconds; " unsprayed rows, 50 bu. " firsts " and 57⅚ bu. " seconds."

Increase in yield due to spraying three times, 28⅔ bu. per acre.
Increase in yield due to spraying six times, 52½ bu. per acre.

There was a little early blight, but no late blight and no rot. After July 15 the plants suffered from both drought and flea beetles. From this time until the plants were all dead the sprayed rows were noticeably superior to the unsprayed ones. This difference was more marked during the last week in July than on August 21.

RESULTS IN 1910.

TABLE XVII.— YIELD BY SERIES AT GENEVA IN 1910.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 6, 20 and Aug. 3......................	244	30
II......	2, 5, 8, 11 and 14....	July 6, 20, Aug. 3, 18, Sept. 2 and 19........	285	25
III......	3, 6, 9, 12 and 15....	Not sprayed.............................	222	35

Increase in yield due to spraying three times, 22 bu. per acre.
Increase in yield due to spraying six times, 63 bu. per acre.

A very little damage was done by flea beetles and early blight. The chief factor was late blight which appeared about the middle of September and wrought considerable havoc in the north one-third of the field. In this region there was, also, some loss from rot — 43 bu. per acre on Series I, 10.8 bu. on Series II and 37.2 bu. on Series III.

TABLE XVIII.— YIELD BY SERIES AT RIVERHEAD IN 1910.*

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	4, 7, 10 and 13......	June 20, July 16 and Aug. 1.................	163	45
II......	5, 8, 11 and 14......	June 20, July 3, 16, Aug. 1 and 13...........	174	22
III......	6, 9, 12 and 15......	Not sprayed.............................	148	57

* Incorrectly reported in Bulletin 338. Rows 1, 2 and 3 should have been excluded because of their irregular yields due to some other cause than spraying.

Increase in yield due to spraying three times, 14¾ bu. per acre.
Increase in yield due to spraying five times 25½ bu. per acre.

The plants suffered severely from drought and were moderately attacked by flea beetles, plant lice and early blight; but late blight and rot were wholly absent.

DETAILS OF THE TEN-YEAR EXPERIMENTS IN 1911.

AT GENEVA.

During 1911 the experiment at Geneva was carried out in practically the same manner as in previous years. As usual, there were fifteen rows 290.4 feet long by three feet wide. Planting was done by hand on May 22 and 23. The variety was Rural New Yorker No. 2. Each row received ten pounds (500 lbs. per acre) of chemical fertilizer applied by hand as uniformly as possible in the open furrow at planting time. The soil was of the same general character as that used for the experiment during the past eight years, namely, a rather heavy gravelly clay loam with good surface drainage. Because of the very dry weather which prevailed for about seven weeks after planting the young potato plants made a slow, spindling growth at first and never attained large size. However, the unfavorable conditions at the start were partly offset by an unusually long growing season — May 22 to October 27 — with an abundance of rain in the last few weeks.

The five rows constituting Series I were sprayed three times with bordeaux — July 6, 20 and August 17.

The five rows constituting Series II were sprayed seven times with bordeaux — July 6, 20, August 4, 17, 31, September 15 and 30.

The five rows constituting Series III (check) were not sprayed at all with bordeaux.

Colorado potato beetles or "bugs" were eliminated from the experiment by means of paris green which was applied over the entire field twice and to portions of the check rows a third time. The first two applications were made on the dates of the first two sprayings (July 6 and 20), the paris green being mixed with the bordeaux used on Series I and II while on the check rows (Series III) it was applied with lime water. The third application of paris green (made August 17) was required only on certain portions of the check rows which were being slightly injured by bugs. In all cases the paris green was used at the rate of one pound to fifty gallons.

In each spraying the bordeaux was applied uniformly and very thoroughly with a knapsack sprayer, the quantity varying from about 100 gallons in the first spraying to about 250 gallons per acre in the later ones. The bordeaux used contained six pounds of copper sulphate in each 50 gallons and lime somewhat in excess of the quantity required to satisfy the potassium ferrocyanide test. No attempt was made to spray the undersurface of the leaves.

Until nearly the middle of September the unsprayed rows appeared to be in as good condition as the sprayed ones. On September 15 a contrast was observed for the first time. The foliage of the rows sprayed every two weeks was perfect while that of the unsprayed rows began to show tip burn. Although it was not marked there was certainly a difference. From this time until about October 15, when the unsprayed rows were entirely dead, the contrast between sprayed and unsprayed rows became gradually more and more pronounced. The condition of the rows sprayed three times was intermediate between that of unsprayed rows and rows sprayed every two weeks. On all rows, the plants in the north half of the field died somewhat earlier than in the south half. Viewed from the south end on October 23 the rows sprayed seven times appeared to be in nearly full foliage; while rows sprayed three times showed only an occasional green branch; and the check rows were entirely dead. The first killing frost came on the night of October 27, at which time the rows sprayed seven times were still quite green over the south half of their length though nearly dead over the north half.

There was no late blight whatever, only a very little early blight and a very little flea beetle injury. The unsprayed rows were affected by no disease of any consequence except tip burn and even of that there was only a moderate amount. As the plants were still partially alive twenty weeks after planting it is clear that they could not have been very much injured by anything. Yet spraying increased the yield at the rate of 93 bu. per acre. Plainly, we have here a striking example of the beneficial influence of bordeaux in the absence of diseases and insect enemies. Of course,

the unusually long growing season gave the bordeaux an opportunity to exert its full influence. Had frost come on October 1, as frequently happens, the difference in yield between sprayed and unsprayed rows would have been much smaller; and had frost come on September 14, when potato fields in many localities in the State were killed, the gain from spraying would probably have been very small.

Several persons who saw the experiment during October after the contrast had become marked raised the question as to whether the sprayed rows were increasing their yield at that time. They must have been increasing their yield rapidly else they could not have outyielded the unsprayed rows by as much as 93 bu. per acre.

Apparently, the increased yield of the sprayed rows was due chiefly to the larger average size of the tubers. On the rows sprayed seven times the tubers were quite large — so large, in fact, that some difficulty might have been experienced in selling them at full price in the regular potato market.

The potatoes were dug by hand and the product of each row sorted and weighed as in previous years. The yield by rows is shown in the following table:

TABLE XIX.— YIELDS IN THE EXPERIMENTS AT GENEVA IN 1911.

Row.	Treatment.	Yield per row.*		Yield per acre.			
		Marketable.	Culls.	Marketable.		Culls.	
		Lbs.	*Lbs.*	*Bu*	*lbs.*	*Bu.*	*lbs.*
1.....	Sprayed 3 times.....................	297	4	247	30	3	20
2.....	Sprayed 7 times.....................	364	6	303	20	5	00
3.....	Unsprayed..........................	205½	9½	171	15	7	55
4.....	Sprayed 3 times.....................	278	8	231	40	6	40
5.....	Sprayed 7 times.....................	350	6	291	40	5	00
6.....	Unsprayed..........................	226	9	188	20	7	30
7.....	Sprayed 3 times.....................	265½	5	221	15	4	10
8.....	Sprayed 7 times.....................	301	5½	250	50	4	35
9.....	Unsprayed..........................	208	10½	173	20	8	45
10.....	Sprayed 3 times.....................	245	8½	204	10	7	5
11.....	Sprayed 7 times.....................	332	4	276	40	3	20
12.....	Unsprayed..........................	198	6	165	00	5	00
13.....	Sprayed 3 times.....................	266	10½	221	40	8	45
14.....	Sprayed 7 times.....................	323	6	269	10	5	00
15.....	Unsprayed..........................	†275	8	229	10	6	40

* Rows 290.4 feet long by 3 feet wide, making the area of each row exactly one-fiftieth acre.

† At the time of the second spraying, Row 15 was sprayed with bordeaux by mistake. This probably explains, in part, why it yielded so much more than the other check rows; but there must have been, also, some other disturbing factor else it would not have outyielded Row 13 sprayed three times.

The five rows sprayed three times constitute Series I and the average yield of these rows makes the yield for Series I. The yields given for Series II and III have been computed in the same way. The yield by series is shown in the following table:

TABLE XX.— YIELD BY SERIES AT GENEVA IN 1911.

Series.	Rows.	Dates of spraying.	Yield per acre.*	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 6, 20 and Aug. 17....................	225	15
II......	2, 5, 8, 11 and 14....	July 6, 20, Aug. 4, 17, 31, Sept. 15 and 30....	278	20
III......	3, 6, 9, 12 and 15....	Not sprayed............................	185	25

* Marketable tubers only.

Increase in yield due to spraying three times, 40 bu. per acre.
Increase in yield due to spraying seven times, 93 bu. per acre.

AT RIVERHEAD.

With minor variations the experiment at Riverhead was carried out in the same manner as the one at Geneva. The potatoes were of the variety Carman No. 1. They were planted April 14. The soil was sandy loam.

The five rows of Series I were sprayed with bordeaux mixture three times — May 30, June 24 and July 12.

The five rows of Series II were sprayed with bordeaux mixture five times — May 30, June 14, 28, July 12 and 26.

The five rows of Series III (check), received no bordeaux.

Bugs were controlled with paris green used at the rate of one and one-half pounds to fifty gallons. On Series I and II it was applied with the bordeaux three times and on Series III twice (June 24 and July 12), with lime water.

In this experiment flea beetles were plentiful. There was, also, a little early blight, but no late blight and no rot. The chief cause of the low yield was the severe drought which brought about the premature death of the plants on all three series. Table XXI shows the yield by rows and Table XXII the yield by series.

TABLE XXI.— YIELDS IN THE EXPERIMENT AT RIVERHEAD IN 1911.

Row.	Treatment.	Yield per row.*		Yield per acre (computed).			
		Marketable.	Culls.	Marketable.		Culls.	
		Lbs.	*Lbs.*	*Bu.*	*lbs.*	*Bu.*	*lbs.*
1.....	Sprayed 3 times.....................	177	5	147	30	4	10
2.....	Sprayed 5 times.....................	168	3	140	—	2	30
3.....	Unsprayed...........................	199.5	4	166	15	3	20
4.....	Sprayed 3 times.....................	161.5	4	134	35	3	20
5.....	Sprayed 5 times.....................	174.5	6.5	145	25	5	25
6.....	Unsprayed...........................	161	5	134	10	4	10
7.....	Sprayed 3 times.....................	133.5	7	111	15	5	50
8.....	Sprayed 5 times.....................	152.5	6	127	5	5	—
9.....	Unsprayed...........................	164.5	6.5	137	5	5	25
10.....	Sprayed 3 times.....................	152	8	126	40	6	40
11.....	Sprayed 5 times.....................	151	14	125	50	11	40
12.....	Unsprayed...........................	129	9	107	30	7	30
13.....	Sprayed 3 times.....................	183	12	152	30	10	—
14.....	Sprayed 5 times.....................	157	14	130	50	11	40
15.....	Unsprayed...........................	146	12	121	40	10	—

* Rows 290.4 feet long by 3 feet wide, making the area of each row exactly one-fiftieth acre.

TABLE XXII.— YIELD BY SERIES AT RIVERHEAD IN 1911.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13.....	May 30, June 24 and July 12...............	134	30
II......	2, 5, 8, 11 and 14.....	May 30, June 14, 28, July 12 and 26.........	133	50
III......	3, 6, 9, 12 and 15.....	Not sprayed..............................	133	20

Increase in yield due to spraying three times, 1⅙ bu. per acre.
Increase in yield due to spraying five times, ½ bu. per acre.

In all our experience with potato spraying experiments this is the only instance in which five thorough sprayings with bordeaux mixture have failed to increase the yield. What may have been the cause we do not know. Perhaps the severe drought had something to do with it. There is no reason to believe that the unsprayed rows had any advantage over the sprayed rows.

SUMMARY OF RESULTS OBTAINED IN THE TEN-YEAR EXPERIMENTS.

The following table shows the results obtained in the ten-year experiments at Geneva and Riverhead:

TABLE XXIII.— SUMMARY OF THE TEN-YEAR EXPERIMENTS.

Year.	At Geneva.		At Riverhead.	
	Gain per acre due to spraying every two weeks.	Gain per acre due to spraying three times.	Gain per acre due to spraying every two weeks.	Gain per acre due to spraying three times.
	Bu.	*Bu.*	*Bu.*	*Bu.*
1902	123.5	98.5	45	27.7
1903	118	88	56	39.5
1904	233	191	96	56.5
1905	119	107	82	31.5
1906	63	32	53	21.5
1907	73.7	44	31	18
1908	39	29.5	15.7	10.7
1909	49.7	38.7	52.5	28.7
1910	63	22	25.5	14.7
1911	93	40	.5	1.1
Average	97.5	69	45.7	25

The ten-year experiments are now concluded. They have been carried out during ten consecutive years very nearly as planned. Three times (twice at Geneva and once at Riverhead) it has been necessary to reject the data from certain parts of the experiment field because of inequalities due to other causes than spraying; but there has been no crop failure or serious accident to break the continuity of the experiments.

One striking feature of Table XXIII is the difference between the gains obtained at Geneva and those obtained at Riverhead. At Geneva, the increase in yield due to spraying is more than double what it is at Riverhead. It is probable that this difference is due partly to differences in the temperature and rainfall in the two localities and partly to difference in soil. Throughout the whole ten years the Riverhead experiment has been on light, sandy soil while the experiment at Geneva has been on rather heavy clay loam.

The results of these experiments, considered in connection with other experiments and observations made by the writers, indicate that the average benefit from spraying potatoes in New York may vary very widely in different localities and on different soils. The average increase of 45 bu. per acre obtained at Riverhead is probably the minimum average increase to be expected from thorough spraying since potatoes are rarely planted on lighter, drier soil than that used for the experiment at Riverhead. On the other hand, the maximum average is probably over 100 bu. per acre. Many thousands of acres are planted on heavy soils in low situations where the ravages of blight and rot are considerably greater than on such land as was used for the experiment at Geneva. What the mean average for the State may be cannot be stated, even approximately. It can only be said to be large — somewhere between 50 and 100 bu. per acre.

Five to seven sprayings in the course of the season gave much better results than three sprayings. Undoubtedly, the three sprayings would have made a better showing had they been applied later in the season; but this was impracticable because of the necessity of early spraying to control "bugs." All of our experience in spraying potatoes with bordeaux mixture indicates that the more frequently and thoroughly the plants are sprayed the better it is for them and the larger will be their yield of tubers.

In these experiments we have been able to greatly reduce the ravages of early blight, late blight, rot, tip burn and flea beetles, but have not succeeded in completely controlling any of them in times of severe attack.

FARMERS' BUSINESS EXPERIMENTS.

During the season of 1911 fourteen farmers in different parts of the State conducted business experiments for the Station. The object of these experiments is to determine the actual profit in spraying potatoes under farm conditions. The methods employed were essentially the same as in previous years. An accurate record was kept of all of the expense of spraying, including labor,

chemicals and wear of machinery. In each experiment a strip of a few rows was left unsprayed for comparison.

"Spraying," as used in this bulletin, means the application of bordeaux mixture exclusively. The application of paris green or arsenite of soda in lime water is not called spraying.

Whenever "arsenite of soda" is mentioned it should be understood to mean the stock solution prepared by the Kedzie formula — one pound white arsenic, four pounds sal soda and one gallon of water boiled together twenty minutes.

By "test rows" is meant the rows used in determining the amount of the increase in yield due to spraying. These are, usually, the middle unsprayed row and the second sprayed row on either side.

Unless otherwise stated, the yields given are for marketable tubers only.

The price used in computing the value of the increased yield is, in every case, the market price for potatoes in the locality where the experiment was made on the date on which the test rows were dug.

In ten of the experiments a few rows were double-sprayed; that is, at each spraying these rows were treated twice. The object of this was to determine whether more thorough spraying would be profitable.

THE LANCASTER EXPERIMENT.

Conducted by F. W. Handy, Lancaster, N. Y. Six acres of potatoes were sprayed four times (July 31, Aug. 7, 16 and 24) with bordeaux mixture, formula 4¾-6-50. The spraying was done with a one-horse, four-row "Iron Age" sprayer carrying one nozzle per row. The potato field was about 100 yards from the water supply. The water was pumped by a gasoline engine. Four rows 664 feet long by 32 inches wide were left unsprayed for a check. Owing to the absence of bugs it was unnecessary to use any poison. On each side of the check a strip of four rows was double-sprayed at each spraying. Apparently, the plants were not injured by blight, yet an occasional rotten tuber was found at digging time.

The items of expense were as follows:

150 lbs. copper sulphate @ 5.5 cts.	$8 25
200 lbs. lime	80
24 hrs. labor for man and horse @ 25 cts.	6 00
Allowance for wear of sprayer	2 00
Total	$17 05

Average expense of spraying, $2.84 per acre.

The test rows yielded as follows:

Two double-sprayed rows, 811 lbs.= 166.2 bu. per acre.

Two single-sprayed rows, 714 lbs.= 146.4 bu. per acre.

Two check rows, 735.5 lbs.= 150.8 bu. per acre.

Single-spraying resulted in a loss of 4.4 bu. per acre, while double-spraying gave a gain of 15.4 bu. per acre.

The market price of potatoes being sixty cents per bushel, the total loss per acre from single-spraying was $5.48, while from double-spraying there was a net profit of $3.56 per acre.

THE BATAVIA EXPERIMENT.

Conducted by G. A. Prole, Batavia, N. Y. Thirty acres of potatoes were sprayed four times with a two-horse, four-row "Iron Age" sprayer carrying one nozzle per row. The dates of spraying were July 7, 20, August 1 and 15. Water was obtained from a well about fifty rods from the field. It was pumped by a windmill. In the first and third sprayings arsenite of soda was used with the bordeaux at the rate of four quarts to sixty gallons. The check consisted of a strip of three unsprayed rows 953 feet long and 2.8 feet apart. These were treated twice (July 7 and August 1) with arsenate of lead to control bugs. The plants grew to large size. They became considerably affected with tip burn. Traces of late blight were discovered September 26, but no appreciable damage was done by it and no rotten tubers were found at digging time. Sprayed and unsprayed rows appeared equal throughout the season.

The expense account contained the following items:

384 lbs. copper sulphate @ 6 cts	$23 04
3 bu. lime @ 25 cts	75
32 lbs. white arsenic @ 8 cts	2 56
64 lbs. sal soda @ 1½ cts	96
80 hrs. labor for man and horse @ 30 cts	24 00
Arsenate of lead	50
Wear on sprayer	5 00
Total	$56 81

The test rows (variety Sir Walter Raleigh), yielded as follows:

Two sprayed rows, 1,474 lbs.= 200.4 bu. per acre.

Middle check row, 682 lbs.= 185.5 bu. per acre.

Gain from spraying, 14.9 bu. per acre.

Potatoes being worth sixty cents per bushel, the gain of 14.9 bu. has a value of $8.94. After subtracting $1.88, the expense of spraying, there remains *a net profit of $7.06 per acre.*

THE ALBION EXPERIMENT.

Conducted by Ora Lee, Jr., Albion, N. Y. Seventeen acres of potatoes (variety Sir Walter Raleigh), were sprayed seven times between June 27 and August 29. The spraying outfit consisted, essentially, of a 250-gallon tank and a Friend pump worked by a gasoline engine. It was mounted on a four-wheeled cart drawn by two horses. Ten rows were covered at each passage. The water required was pumped by a windmill from a well only a few rods from the potato field. Arsenate of lead, at the rate of 20 lbs. to 250 gallons, was used with the bordeaux in the first, second and fourth sprayings. On the same dates the same poison (with water) was applied to the check which consisted of four rows 962 feet long by 32 inches wide. Ten rows on one side of the check were double-sprayed. During the last three weeks of growth the sprayed rows made a better appearance than the unsprayed rows. Double-sprayed rows held their foliage better than single-sprayed rows. The principal disease was tip burn, which was very prevalent.

The items of expense were as follows:

1180 lbs. copper sulphate @ $4.33 per cwt.	$51 10
4 bbls. lump lime @ $1.15	4 60
10 sacks (40 lbs. each) ground lime @ 25 cts.	2 50
300 lbs. arsenate of lead @ 8 cts.	24 00
122½ hrs. man labor @ 15 cts.	18 38
152 hrs. horse labor @ 10 cts.	15 20
Wear of sprayer	25 00
Gasoline and oil	4 00
Total	$144 78

The yields were as follows:

Four double-sprayed rows, 3,485 lbs. = 246.5 bu. per acre.

Four single-sprayed rows, 2,948 lbs. = 208.5 bu. per acre.

Four check rows, 2,779 lbs. = 196.6 bu. per acre.

The above figures show that single-spraying, costing $8.52 per acre, increased the yield only 11.9 bu. per acre worth $7.14. Therefore, it was done at *a loss of $1.38 per acre.* On the other hand, double-spraying resulted in a net profit of $12.90 per acre.

THE ANDOVER EXPERIMENT.

Conducted by J. M. Greene & Son, on a field of 8.5 acres at Andover, N. Y. Four rows were left unsprayed for a check. A strip of four rows adjoining the check on either side was single-sprayed with bordeaux five times (See diagram on next page). The remainder of the field was double-sprayed five times. Messrs. Greene were led to double-spray so much of their acreage because of the results of an experiment which they made in 1910.[1]

In 1911 the spraying was done very nearly as in 1910. The sprayer used was a two-horse "Watson" covering four rows at each passage. One nozzle per row was used in the first three sprayings and two nozzles per row in the last two sprayings. Water for the preparation of the bordeaux was taken from a spring about ten rods from the potato field. Owing to the absence of bugs it was unnecessary to use any poison even on the check rows. Flea beetles and blight, also, were almost entirely absent and only a few rotten tubers were found at digging time. Apparently, the plants suffered from nothing which spraying might be expected to prevent. There was little if any contrast in appearance between sprayed and unsprayed rows.

The items of expense were as follows:

215 lbs. copper sulphate @ 5 cts.	$10 75
215 lbs. lime @ 1 ct.	2 15
Labor for man and team and allowance for wear of sprayer, estimated[2] @ 80 cts. per acre for double-spraying	34 00
Total	$46 90

Expense of making five double-sprayings, $5.52 per acre.

Expense of making five single-sprayings, $2.76 per acre.

The plants were killed by frost on September 14. Had they been permitted to complete their growth the sprayed rows would probably have made a better showing. The small differences in yield of the different test rows was due, probably, to something else than spraying. This is shown by the fact that one of the check rows outyielded the other by 44 lbs. or 19.8 bu. per acre.

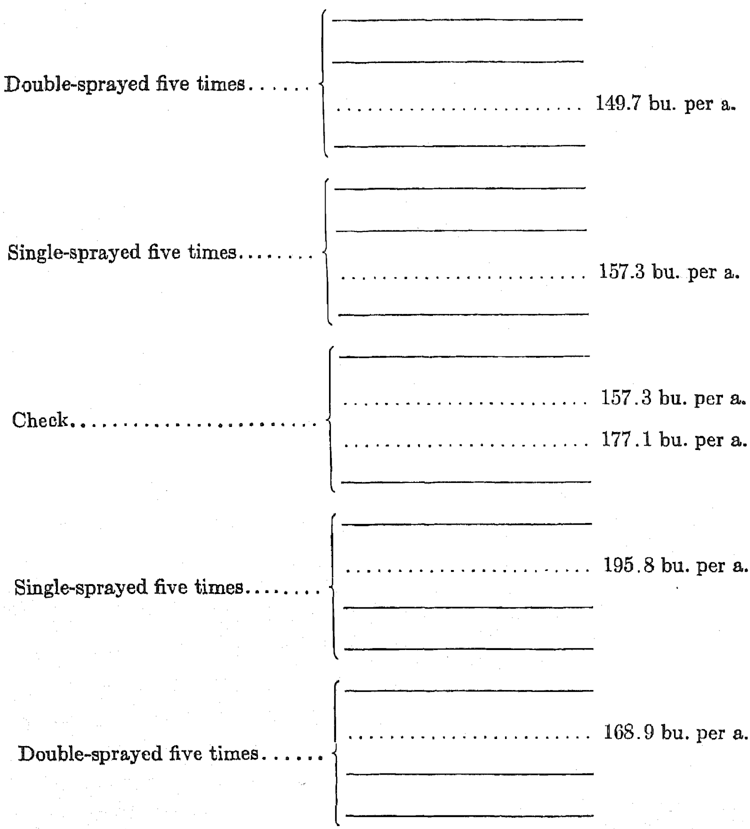
In the accompanying diagram the test rows[3] are indicated by dotted lines and followed by their rate of yield.

[1] Reported in Bul. 338 of this Station, pages 134–135.

[2] Messrs. Greene think this estimate rather high. It is unfortunate that an actual record was not kept.

[3] The test rows were 540 ft. long by 3 ft. wide.

DIAGRAM I.— SHOWING LOCATION AND YIELDS OF TEST ROWS IN THE ANDOVER EXPERIMENT.



Average yield of double-sprayed rows, 159.3 bu. per acre.
Average yield of single-sprayed rows, 176.6 bu. per acre.
Average yield of check rows, 167.2 bu. per acre.
Gain from single-spraying, 9.4 bu. per acre.
Loss from double-spraying, 7.9 bu. per acre.

With potatoes selling at 55 cts. per bushel, 9.4 bu. would have a value of $5.17. Subtracting from this the expense of spraying, $2.76 per acre, there remains $2.41 per acre as the net profit from single-spraying five times. Computed in a similar manner the *loss* from double-spraying five times was $9.86 per acre.

THE PHELPS EXPERIMENT.

Conducted by J. A. Page, Phelps, N. Y. Fourteen acres of potatoes (in three fields) were sprayed four times. The spraying was done with a two-horse, five-row Brown sprayer carrying one nozzle per row. In each field there was a check of five rows. At one side of each check a strip of five rows was double-sprayed. Tip burn was severe in both fields and in the west field there was also a little early blight, but there was no late blight and few flea beetles. Bugs were kept under control by two applications of arsenate of lead. In the east field spraying made little if any difference in the appearance of the foliage, but in the west field a contrast between sprayed and unsprayed rows was noticeable.

The expense of spraying was as follows:

250 lbs. copper sulphate @ 5 cts.	$12 50
2½ bbls. lime @ $1.50	3 75
210 lbs. arsenate of lead @ 8 cts.	16 80
40 hrs. labor for man and team @ 35 cts.	14 00
Wear of sprayer	10 00
Total	$57 05

In the east field the rows were 674 feet long by 3 feet wide. Double-sprayed rows yielded at the rate of 108.6 bu., single-sprayed rows 87.6 bu. and check rows 98.4 bu. per acre. In the west field the rows were 1757 x 3 ft. Dougle-sprayed rows yielded at the rate of 123.9 bu., single-sprayed rows 109.4 bu. and check rows 96.4 bu. per acre.

Hence, single-spraying gave a loss of 10.8 bu. in the east field and a gain of 13 bu. per acre in the west field, making an average gain of 1.1 bu. per acre. Double-spraying gave a gain of 10.2 bu. in the east field and 27.5 bu. in the west field, making an average gain of 18.8 bu. per acre.

Potatoes being worth 70 cts. per bushel, single-spraying resulted in a loss of $3.39 per acre while double-spraying gave an average net profit of $4.84 per acre.

THE DRYDEN EXPERIMENT.

Conducted by D. R. Trapp, Dryden, N. Y. The experiment included three fields containing eight acres of potatoes. Five applications of bordeaux were made with a two-horse, four-row "Iron Age" sprayer carrying two nozzles per row. Bordeaux of the 7-9-55 formula was used in the first three sprayings while in the last two sprayings 8-12-55 bordeaux was used. In the first two sprayings paris green was added to the bordeaux at the rate of three pounds to 55 gallons for the control of bugs. In one field a strip of three unsprayed rows was left for a check. These rows were dusted twice with paris green and flour, which gave good protection against bugs. The test rows were of the variety Gold Coin. They suffered severely from tip burn and flea beetles, but were unaffected by blight. Neither the tip burn nor the flea beetles were materially checked by spraying. There was very little contrast between sprayed and unsprayed rows.

The expense of spraying was as follows:

222 lbs. copper sulphate @ 5 cts	$11 10
300 lbs. lime	1 90
43 lbs. paris green @ 20 cts	8 60
40 hrs. labor for man and team @ 40 cts	16 00
Wear on sprayer	5 00
Total	$42 60

Expense of spraying one acre five times, $5.32.

Expense of spraying one acre once, $1.07.

The test rows (300 ft. x 32 in.) yielded as follows:

East sprayed row, 210 lbs.= 190.6 bu. per acre.

West sprayed row, 206 lbs.= 187 bu. per acre.

Average yield of sprayed rows, 188.8 bu. per acre.

Middle check row, 183 lbs.= 166.1 bu. per acre.

Gain from spraying, 22.7 bu. per acre.

Potatoes being worth 55 cents per bushel at time of digging, the spraying resulted in a net profit of $7.16 per acre.

THE CORTLAND EXPERIMENT.

Conducted by G. H. Hyde, Cortland, N. Y. A field of eight acres was sprayed four times — seven and one-third acres single-sprayed and two-thirds of an acre double-sprayed. A strip of three unsprayed rows separated the single-sprayed portion of the field from the double-sprayed portion. The bordeaux (6-6-60 formula) was applied with a one-horse, four-row "Watson" sprayer carrying two nozzles per row. Paris green was used with the bordeaux in the first two sprayings. It was also used on the check rows twice, with water. Before the end of the season the unsprayed rows became quite conspicuous owing to their inferior condition due, chiefly, to the ravages of flea beetles. The spraying checked the flea beetles considerably. There was no blight and very little tip burn.

The expense account contained the following items:

200 lbs. copper sulphate @ 5½ cts.	$11 00
200 lbs. lime	1 40
24 lbs. paris green @ 21 cts.	5 04
24 hrs. labor for man and horse @ 30 cts.	7 20
Wear of sprayer	6 00
Total	$30 64

Expense per acre for four single-sprayings, $3.54.

Expense per acre for four double-sprayings, $7.08.

The test rows (400 x 3 ft.) yielded as follows:

One double-sprayed row, 339 lbs. = 205.1 bu. per acre.

One single-sprayed row, 271 lbs. = 164 bu. per acre.

One check row, 144.6 bu. per acre.

Gain from double-spraying, 60.5 bu. per acre.

Gain from single-spraying, 19.4 bu. per acre.

Potatoes being worth 60 cts. per bushel, 19.4 bu. would have a value of $11.64. Subtracting from this the expense of single-spraying, $3.54 per acre, there remains a net profit of $8.10 per acre. Similarly, 60.5 bushels would be worth $36.30 from which there must be deducted $7.08, leaving a net profit of $29.22 per acre for double-spraying.

THE CASSVILLE EXPERIMENT.

Conducted by P. S. Doolittle, Cassville, N. Y. The experiment field contained six acres of potatoes (variety Carman No. 3), which were sprayed five times with a two-horse, seven-row Brown sprayer, carrying one nozzle per row. The check consisted of a strip of seven unsprayed rows 681 feet long. On either side of the check a strip of seven rows was double-sprayed as shown in the diagram on the opposite page. The bordeaux used was of the 5-5-50 formula. Paris green ($1\frac{1}{2}$ lbs. to 50 gals.) was used with the bordeaux in the first two sprayings. On the same dates (July 8 and 20), the check rows were treated with the same quantity of paris green applied with water. Tip burn was severe and there were some flea beetles, but both early and late blight were absent and there was no rot. Considering that there was no blight and that the plants were killed by an early frost on September 14 the large difference in yield between sprayed and unsprayed rows is remarkable. However, the experiment seems to have been a fair one in all respects.

The items of expense were as follows:

175 lbs. copper sulphate @ 5½ cts	$9 63
180 lbs. lime @ 1¼ cts	2 25
22 lbs. paris green @ 22 cts	4 84
21½ hrs. man labor @ 20 cts	4 30
18 hrs. labor for team @ 20 cts	3 60
Wear of sprayer	6 00
Total	$30 62

Expense per acre, for five sprayings, $5.10.

The accompanying diagram shows the location of the test rows with reference to each other. They are indicated by dotted lines and followed by their yield.

DIAGRAM 2.— SHOWING LOCATION AND YIELDS IN THE CASSVILLE EXPERIMENT.

Double-sprayed five times......	188.7 bu. per a.
Single-sprayed five times........	166.1 bu. per a.
Check........................	81.7 bu. per a.
Single-sprayed five times........	162.5 bu. per a.
Double-sprayed five times......	177.3 bu. per a.

Average yield of double-sprayed rows, 183 bu. per acre.

Average yield of single-sprayed rows, 164.3 bu. per acre.

Yield of middle check row, 81.7 bu. per acre.

Gain due to single-spraying, 82.6 bu. per acre.

Gain due to double-spraying, 101.3 bu. per acre.

With potatoes selling at 70 cts. per bushel, single-spraying gave a net profit of $52.72 per acre while double-spraying gave a net profit of $60.71 per acre.

THE OGDENSBURG EXPERIMENT.

Conducted by Andrew Tuck, Ogdensburg, N. Y. About 4.6 acres of potatoes were sprayed six times between July 18 and September 4. A one-horse, four-row Aspinwall sprayer was used. One nozzle per row was used in the first three sprayings and two nozzles per row in the last three. A strip of three unsprayed rows constituted the check. In all six sprayings paris green was used with the bordeaux at the rate of three pounds to fifty gallons. Paris green in water was applied to the check rows three times by means of a sprinkling pot without any apparent injury to the foliage. Four rows on one side of the check were double-sprayed. Some contrast appeared between the check and the sprayed rows due to the check rows being more injured by tip burn, flea beetles and bugs. On the check rows bugs were not as well controlled as they should have been to make the experiment entirely fair.

The following items appear in the expense account:

105 lbs. copper sulphate @ 7½ cts	$7 88
105 lbs. lime	1 10
60 lbs. paris green @ 25 cts	15 00
36 hrs. labor for man and horse @ 30 cts	10 80
Wear of sprayer	1 00
Total	$35 78

Expense of single-spraying six times, $7.78 per acre.

Expense of double-spraying six times, $15.56 per acre.

The test rows (variety, Green Mountain; 171 x 3 ft.) yielded as follows:

One double-sprayed row, 138 lbs.= 195.3 bu. per acre.

Two single-sprayed rows, 253 lbs.= 179 bu. per acre.

One check row, 103 lbs.= 145.8 bu. per acre.

Gain from single-spraying, 33.2 bu. per acre.

Gain from double-spraying, 49.5 bu. per acre.

Market price of potatoes, $1.00 per bushel.

Net profit from single-spraying, $25.42 per acre.

Net profit from double-spraying, $33.94 per acre.

THE CHATEAUGAY EXPERIMENT.

Conducted by O. Smith & Son, Chateaugay, N. Y. Twelve acres of potatoes were sprayed four times with a one-horse, four-row "Iron Age" sprayer. Two unsprayed strips of three rows each were left for checks.

Two rows on each side of both checks were double-sprayed.

The bordeaux was made by the 6-6-50 formula. To each fifty gallons of bordeaux mixture used in the first three sprayings there were added three pounds of paris green and two quarts of arsenic-sal soda solution for the control of bugs. The checks were treated four times with paris green. In Test No. 1 the test rows were of the variety New National; in Test No. 2 they were of the variety Sulphic Beauty. There were some flea beetles and considerable tip burn, particularly in Test No. 1, but there was no blight. In both tests there was a slight contrast between sprayed and unsprayed rows.

The items of expense were as follows:

260 lbs. copper sulphate @ 6⅔ cts	$17 40
2½ bbls. lime @ $1.08	2 70
53 lbs. paris green @ 25 cts	13 25
18 lbs. white arsenic @ 6½ cts	1 17
72 lbs. sal soda @ 2½ cts	1 80
43 hrs. labor for man and horse @ 30 cts	12 90
Total	$49 22

Expense of spraying, $4.10 per acre.

The yields were as follows:

Test No. 1. Rows 1,066 x 3 ft.

One double-sprayed row, 407 lbs.= 92.4 bu. per acre.

One single-sprayed row, 526 lbs.= 119.4 bu. per acre.

One check row, 396 lbs.= 89.9 bu. per acre.

Test No. 2. Rows 353 x 3 ft.

Two double-sprayed rows, 181 lbs.= 62 bu. per acre.

Two single-sprayed rows, 216 lbs.= 74 bu. per acre.

Two check rows, 160 lbs.= 54.8 bu. per acre.

Upon averaging the results of the two tests it is found that single-spraying gave a gain of 24.4 bu. per acre and double-spraying only 4.9 bu. per acre. The net profit from single-spraying was $11.76 per acre and the loss from double-spraying $5.02 per acre. The cause of these irregular results is unknown.

THE PLATTSBURGH EXPERIMENT.

Conducted by Pardy Brothers, Plattsburgh, N. Y. Thirteen acres of potatoes were sprayed all over three times and about four-sevenths of the field (including the test rows) were sprayed a fourth time. A strip of six unsprayed rows constituted the check. Bordeaux mixture of the 4-5-50 formula was used. It was made with water pumped by hand from a well about one-fourth mile from the potato field. The sprayer used was a two-horse, six-row "Aroostook" carrying one nozzle per row. Before the experiment was commenced the entire field was treated twice with a strong solution of arsenite of soda in water containing as much lime as could be forced through the nozzles. This was done in an attempt to control flea beetles and leaf hoppers. As might have been expected, the plants were considerably injured, but this does not affect the experiment since the test rows were all treated alike. The plants were somewhat affected by tip burn, but there was no blight.

The items of expense were as follows:

210 lbs. copper sulphate @ $6.25 per cwt.	$13 12
Lime	1 00
257 lbs. sal soda @ 1¼ cts.	3 22
20 lbs. arsenate of lead @ 11 cts.	2 20
54 lbs. white arsenic @ 9 cts.	4 86
50 hrs. labor for man @ 15 cts.	7 50
40 hrs. labor for team @ 20 cts.	8 00
Wear on sprayer	8 00
Total	$47 90

Expense of spraying one acre four times, $4.68.

The test rows (var. Rose of Erin) yielded as follows:

Two sprayed rows, 224 lbs.= 69 bu. per acre.

Two check rows, 199 lbs.= 61.3 bu. per acre.

Gain from spraying, 7.7 bu. per acre.

The low yields were due, largely, to the severe drought and early frost. With potatoes at 75 cts. per bushel spraying apparently resulted in a net profit of $1.09 per acre.

THE GREENWICH EXPERIMENT.

Conducted by P. C. Billings, Greenwich, N. Y. Four and one-half acres of potatoes were double-sprayed four times with a two-horse six-row "Aroostook" sprayer carrying one nozzle per row. At each spraying a portion of the field was double-sprayed so that total amount of work done was equal to spraying 25.8 acres once. The last spraying, made September 12, could have been of little or no benefit as the plants were killed by frost on September 14. In different sprayings the strength of the bordeaux varied from 5-5-50 to 7½-7½-50. The check consisted of three rows 736 feet long by 2.9 feet wide. For the control of bugs paris green, at the rate of one pound to fifty gallons, was applied with the bordeaux in the first three sprayings. The check rows received a single application of paris green yet they were not injured by bugs. On account of a severe drought the plants were much affected with tip burn. Blight and flea beetles were absent. The superior condition of the sprayed rows as compared with the check rows indicated that spraying checked the tip burn very materially.

The expense account contained the following items:

99 lbs. copper sulphate @ 6½ cts.	$6 43
99 lbs. lime @ 1 ct.	99
10 lbs. paris green @ 20 cts.	2 00
13 hrs. labor for man @ 15 cts.	1 95
10 hrs. labor for team @ 30 cts.	3 00
Wear on sprayer	5 00
Total	$19 37

Expense of four double-sprayings, $6.40 per acre.

The test rows (variety Noxall) yielded as follows:

Two double-sprayed rows, 492 lbs.= 83.6 bu. per acre.

One single-sprayed row, 182 lbs.= 61.9 bu. per acre.

Gain from spraying, 21.7 bu. per acre.

Potatoes being worth 70 cts. per bushel at digging time the net profit from spraying in this experiment was $8.79 per acre.

THE GLEN HEAD EXPERIMENT.

Conducted by G. T. Powell, Glen Head, Long Island. Fifteen acres of potatoes were sprayed five times (June 14, 29, July 14, 20, and August 7) with bordeaux applied by means of a one-horse, four-row "Spramotor" sprayer carrying two nozzles per row. Four rows were left unsprayed for a check. Four rows on each side of the check were double-sprayed. Arsenite of soda was used with the bordeaux in the first two sprayings at the rate of 3 qts. of the stock solution to 50 gals. of bordeaux. The check was kept free from bugs by one application of lead arsenate. Flea beetles were numerous and there was much tip burn but no blight. A marked contrast between the sprayed and unsprayed rows indicated that spraying had checked both tip burn and flea beetles, but when the yields were taken very little difference was found between the single-sprayed rows and the check. This leads us to suspect that, in some way, the experiment was unfair.

The items of expense were as follows:

450 lbs. copper sulphate @ 5 cts	$22 50
Lime	6 00
100 lbs. sal soda @ 1½ cts	1 50
40 lbs. white arsenic @ 3 cts	1 20
75 hrs. labor for man and horse @ 25 cts	18 75
Wear of sprayer	5 00
Total	$54 95

Expense per acre for five sprayings, $3.66.

Expense of spraying one acre once, 73 cents.

The test rows (variety Green Mountain) yielded as follows:

Average yield of two double-sprayed rows, 166.5 bu. per acre.

Average yield of two single-sprayed rows, 147.7 bu. per acre.

Yield of one check row, 145.5 bu. per acre.

Gain due to double-spraying, 21 bu. per acre.

Gain due to single-spraying 2.2 bu. per acre.

Potatoes being worth $3 per barrel of 174 lbs. (= $1.03 per bu.), single-spraying resulted in a loss of $1.40 per acre, while double-spraying gave a net profit of $14.31 per acre.

THE JAMESPORT EXPERIMENT.

Conducted by Henry A. Hallock, Jamesport, Long Island. Fifteen acres of potatoes were sprayed five times between June 9 and July 29. The sprayer used was a two-horse, four-row "Iron Age" sprayer, carrying one nozzle per row. The bordeaux was made by the 7-4-50 formula. Four unsprayed rows were left for a check. Four rows adjoining the check on one side were double-sprayed. There being no bugs it was unnecessary to apply poison to the check rows, but, on the sprayed portion of the field, arsenite of soda was used with the bordeaux twice at the rate of four quarts of the stock solution to 50 gallons of bordeaux for the control of flea beetles which were fairly plentiful. There was no late blight and only traces of early blight. At no time during the season was there any marked difference between sprayed rows and the check.

The items of expense were as follows:

1200 lbs. copper sulphate @ 5¼ cts	$63 00
600 lbs. lime	4 00
200 lbs. sal soda @ 1 ct	2 00
100 lbs. white arsenic @ 5 cts	5 00
50 hrs. labor for man @ 20 cts	10 00
50 hrs. labor for team @ 45 cts	22 50
Wear on sprayer	5 00
Total	$111 50

Expense of spraying one acre once, $1.48.

Expense of spraying one acre five times, $7.40.

The test rows (variety Green Mountain) yielded as follows:

Two double-sprayed rows, 1,261 lbs.= 221.1 bu. per acre.

Two single-sprayed rows, 1,150 lbs.= 201.6 bu. per acre.

Two check rows, 1,100 lbs.= 192.9 bu. per acre.

Gain from double-spraying, 28.2 bu. per acre.

Gain from single-spraying, 8.7 bu. per acre.

With potatoes at 90 cts. per bushel single-spraying resulted in a net profit of 43 cts. per acre, while double-spraying gave a net profit of $10.58.

SUMMARY OF BUSINESS EXPERIMENTS IN 1911.

TABLE XXIV.— SHOWING RESULTS OF BUSINESS EXPERIMENTS IN 1911.

Experiment.	Area sprayed.	Number of times sprayed.	Increase or decrease in yield per acre.	Total cost of spraying per acre.	Cost per acre for each spraying.	Net profit or loss per acre.
	A.		Bu.			
Cassville	6	5	82.6	$5 10	$1 02	$52 72
Ogdensburg	4.6	6	33.2	7 78	1 30	25 42
Chateaugay	12	4	24.4	4 10	1 02	11 76
Greenwich	4.5	8*	21.7	6 40	80	8 79
Cortland	8	4	19.4	3 54	89	8 10
Dryden	8	5	22.7	5 32	1 07	7 16
Batavia	30	4	14.9	1 88	47	7 06
Andover	8.5	5	9.4	2 76	55	2 41
Plattsburgh	13	4	7.7	4 68	1 17	1 09
Jamesport	15	5	8.7	7 40	1 48	43
Albion	17	7	11.9	8 52	1 22	—1 38
Glen Head	15	5	2.2	3 66	73	—1 40
Phelps	14	4	1.1	4 16	1 04	—3 39
Lancaster	6	4	—4.4	2 84	71	—5 48

* Four double-sprayings.

Average increase in yield per acre, 18.2 *bushels.*
Average net profit per acre, $8.09.

SUMMARY OF BUSINESS EXPERIMENTS, 1903–1911.

TABLE XXV.— SHOWING RESULTS OF BUSINESS EXPERIMENTS IN 1903–11.

Year.	Number of experi-ments.	Total area sprayed.	Average increase in yield per acre.	Average total cost of spraying per acre.	Average cost per acre for each spraying.	Average net profit per acre.
		A.	Bu.			
1903	6	61.2	57	$4 98	$1 07	$23 47
1904	14	180	62.2	4 98	93	24 86
1905	13	160.7	46.5	4 25	98	20 04
1906	15	225.6	42.6	5 18	985	13 89
1907	14	152.75	36.8	5 90	1 18	17 07
1908	14	200.25	18.5	4 30	92	8 53
1909	12	203.14	24.4	4 15	835	9 55
1910	12	218.5	19.1	4 04	90	4 39
1911	14	161.6	18.2	4 87	96	8 09

Average increase in yield for nine years, 36.1 *bu. per acre.*
Average net profit for nine years, $14.43 *per acre.*

REMARKS ON RESULTS OF BUSINESS EXPERIMENTS.

It is unfortunate that the business experiments were not commenced at the same time as the ten-year experiments in order that

they might have covered the same period; but it is deemed unnecessary to continue them further.

Like the ten-year experiments the business experiments have shown widely varying results in different localities. As a rule, spraying has been more profitable on damp, loam soils than on dry, sandy soils; and better results have been obtained in sheltered than in exposed situations. Also, the fertility of the land and the variety of potato are factors. Most important of all is the thoroughness of spraying.

Some of the experiments have been conducted quite carefully and others carelessly. In several cases there have occurred puzzling differences in yield which were probably due to some other cause than spraying. Although care has been taken in the location of the test rows soil differences have often been a disturbing factor. Sometimes the expense accounts have not been kept properly. In short, the manner in which the experiments have been conducted is far from satisfactory. Nevertheless, it is believed that the results obtained show, approximately, the profit from spraying as practiced by the better class of potato growers in New York. That spraying is profitable there can no longer be any doubt. Even if we make the generous allowances of 30 per ct. for errors there remains an average net profit of $10 per acre. Moreover, there is good reason to believe that the average net profit would have been considerably larger had the spraying been properly done in all of the experiments. In most cases the spraying was not sufficiently thorough. Evidence of this is seen in the results of double-spraying as compared with single-spraying.

The writers hold that these experiments have given a very definite answer to the question, Does it pay to spray potatoes? *The spraying of late potatoes in New York is highly profitable.* No one who grows potatoes extensively can afford to neglect spraying.

SINGLE- VERSUS DOUBLE-SPRAYING.

Observations on the farmers' business experiments led us to suspect that, in most cases, the spraying was not done thoroughly

enough to secure the maximum net profit. In order to get some information on this point arrangements were made with several of the experimenters to double-spray a few rows at each spraying. In some cases a strip on either side of the check was double-sprayed; in others, double-spraying was done on only one side of the check. The double-spraying consisted simply in going over a few rows a second time on the date of each spraying. In computing the net profit from double-spraying it has been assumed that the expense of double-spraying is exactly double that of single-spraying.

Five such experiments were made in 1910 and ten in 1911. The results of the former were published in Bulletin 338 and of the latter in this bulletin, but in order that they may be more readily comprehended they have been tabulated in the accompanying table. The first five experiments given in the table are those made in 1910; the others were made in 1911. Under the heading "Increase or decrease in yield" there are three columns. The first of these relates to single-spraying, the second to double-spraying while the third shows how much doubling the spraying increased the yield over single-spraying. A minus sign indicates a decrease in yield.

The figures given in the last column under "Profit or loss" show how doubling the spraying affected the net profit as compared with single-spraying. It will be observed that double-spraying proved profitable in eleven cases and unprofitable in the other four, the average result being a net profit of $4.44 per acre. The average increase in yield was increased from 20.2 bu. for single-spraying to 34.7 bu. per acre for double-spraying.

Considering that these results were obtained in dry seasons when spraying was less profitable than usual the showing made by double-spraying is highly creditable. The writers are convinced that most potato growers will find it to their advantage to spray more thoroughly than they have been doing in the past.

TABLE XXVI.— SHOWING RESULTS OF DOUBLE-SPRAYING AS COMPARED WITH SINGLE-SPRAYING.

Location of experiment.	Times sprayed.	Increase or decrease in yield.			Expense of single-spraying.	Market price of potatoes.	Profit or loss.
		Single-spraying.	Double-spraying.	Difference.			
		Bu.	*Bu.*	*Bu.*	*Per acre.*	*Cts.*	
Andover	4	33.5	88.4	54.9	$3 58	35	$15 63
Sterling Station	5–7*	—0.9	33.7	34.6	4 28	35	7 83
Glen Head	4	27.9	41.4	13.5	2 87	69	6 44
Jamesport	4	46.7	41.7	—5	4 53	60	—7 53
Southampton	4	7	—26.5	—33.5	2 72	55	—21 19
Cortland	4	19.4	60.5	41.1	3 54	60	21 12
Glen Head	5	2.2	21	18.8	3 66	103	15 71
Albion	7	11.9	49.9	38	8 52	60	14 28
Jamesport	5	8.7	28.2	19.5	7 40	90	10 15
Lancaster	4	—4.4	15.4	19.8	2 84	60	9 04
Ogdensburg	6	33.2	49.5	16.3	7 78	100	8 52
Phelps	4	1.1	18.8	17.7	4 16	70	8 23
Cassville	5	82.6	101.3	18.7	5 10	70	7 99
Andover	5	9.4	—7.9	—17.3	2 76	55	—12 27
Chateaugay	4	24.4	4.9	—19.5	4 10	65	—16 78
Averages	......	20.2	34.7	14.5	....	....	4 44

* There were three tests — one sprayed five times, the others seven times.

VOLUNTEER EXPERIMENTS.

From 1904 to 1910, inclusive, the Station collected and recorded the results of 205 volunteer experiments conducted by farmers in various parts of the State. These experiments were carried out entirely by farmers themselves. Although the data relating to these experiments are probably less reliable than those given for the farmers' business experiments yet they have some value. The details of the experiments have been published in previous bulletins. Only a summary of the results need be given here.

TABLE XXVII.— SHOWING RESULTS OF VOLUNTEER EXPERIMENTS, 1904–1910.

Year.	Number of experiments.	Total area sprayed.	Average gain per acre due to spraying.		Average market price per bushel of potatoes at digging time.
		A.	*Bu.*	*lbs.*	*Cts.*
1904	41	364	58	28	43.5
1905	50	407	59	32	57.0
1906	62	598	53	6	44.5
1907	24	264	30	28	58
1908	11	74	66	18	66
1909	12	115	44	22	51
1910	5	218	68	—	45

Average gain for seven years (205 experiments), 54.3 bu. per acre.

POTATO TROUBLES IN NEW YORK IN 1911.

Over the greater part of the State the growing season of 1911 was very dry. Consequently, late blight (*Phytophthora infestans*) occurred very sparingly. It made its appearance in a few localities, but came too late to cause material injury to the foliage. Neither was there much loss from rot although traces of it were found in a considerable number of fields in central and western New York. Early blight (*Alternaria solani*), also, was scarce. As in 1910, the leading troubles of potato foliage were flea beetle injury and tip burn. Tip burn, especially, was very prevalent.

DIRECTIONS FOR SPRAYING.

In general, commence spraying when the plants are six to eight inches high[1] and repeat the treatment at intervals of 10 to 14 days in order to keep the plants well covered with bordeaux throughout the season. During epidemics of blight it may be advisable to spray as often as once a week.[2] Usually, six applications will be required. The bordeaux should contain four pounds of copper sulphate to each fifty gallons in the first two sprayings and six pounds to fifty gallons in subsequent sprayings.[3]

[1] On Long Island an earlier spraying is sometimes necessary to protect the young plants from flea beetles which attack them severely while they are coming up. For the best success in the control of bugs it is necessary to spray with bordeaux and poison just as soon as a majority of the first brood are hatched. Usually, this occurs when the plants are six to eight inches high. Spray applied three days or more before the bugs hatch will fail to kill many of them, because, in the interval the plants make considerable new growth upon which the bugs can feed with impunity and cause considerable damage before it is time to make the next regular spraying.

[2] On the south shore of Long Island between Southampton and Amagansett this is frequently necessary.

[3] It can not be definitely stated what formula is the best one to use. Much depends upon the quantity used per acre and the manner of its application. Weak bordeaux applied in the form of fine spray which covers the plants thoroughly may give better results than stronger bordeaux carelessly applied in the form of coarse spray. Both the cost of chemicals and the expense of application must be taken into consideration. It is plain, however, that the mixture should be strengthened as the season advances and the danger from blight increases. None of the ready-made bordeaux mixtures on the market are as good as the home-made bordeaux. Neither can the lime-sulphur solution be profitably substituted for bordeaux in spraying potatoes (See Bul. 347 of this Station). In the preparation of bordeaux the writers prefer to use stone lime rather than any of the "prepared" limes.

Whenever bugs or flea beetles are plentiful add one or two pounds of paris green, two quarts of arsenite of soda stock solution or three to five pounds of arsenate of lead to the quantity of bordeaux required to spray an acre.

Thoroughness of application is to be desired at all times, but is especially important when flea beetles are numerous or the weather favorable to blight. The more frequently and thoroughly the plants are sprayed the better. There is no danger of injuring the foliage by too much spraying. Using the same quantity of bordeaux, frequent light applications are likely to be more effective than heavier applications at long intervals; e. g., when a horse power sprayer carrying but one nozzle per row is used, it is better to go over the plants once a week than to make a double spraying once in two weeks. In the first two sprayings, while the plants are small, one nozzle per row may be sufficient; but when the plants become large at least two nozzles per row should be used. Large vines are especially liable to blight and should be sprayed very thoroughly. Such vines will be somewhat injured by the wheels of the sprayer, but the benefit from spraying will far outweigh the damage done.

A single spraying is better than none and will usually be profitable, but more are better. Spraying may prove highly profitable even though the blight is only partially prevented. It is unsafe to postpone spraying until blight appears. Except, perhaps, on small areas, it does not pay to apply poison alone for bugs. When it is necessary to fight insects bordeaux mixture and poison should be used together. For the best results, spraying should be continued as long as the plants live. It is a mistake to discontinue spraying because the weather is dry and no blight present. A late attack of blight may result in heavy loss from rot. As a rule, those who spray most obtain the largest net profit.

Acknowledgment. Throughout the ten years during which this investigation has been in progress many farmers have had a part in the work and given very material assistance. The writers heartily thank these gentlemen for the service they have rendered.

CROWN-ROT OF FRUIT TREES: FIELD STUDIES.*

J. G. GROSSENBACHER.

SUMMARY.

Field studies from 1909 to 1912 have shown that in winter the bark on the trunks of fruit and other trees is often loosened or injured, near or below the surface of the ground; and observations made at intervals throughout the year show that the most severely affected portions of bark die and decay during the subsequent vegetative season, thus giving rise to crown-rot. It was also found that similar bark injuries, resulting in cankered areas or the death of the affected bark, occur in the bark of trunks some distance above ground — at crotches and on parts of branches which appear to be most subject to bending or strain in time of strong winds.

Neither the factors which induce the initial bark-injury nor those causing the subsequent death and decay have been determined experimentally, but were selected from the environment of affected trees in widely separated localities chiefly by elimination and deduction; however, the amount of accumulated circumstantial evidence is so large that there seems to be no doubt about the main causes involved and the time during which they are operative. From the data at hand it appears that the factors which are implicated in the production of the initial injuries are:

1st. An unusually large increase in the diameter of tree trunks during a vegetative season, necessitating an enormous increase in the area of the bark and resulting in high bark tension toward the end of the growing period, or the premature cessation in the process of differentiation of bark tissues owing to some adverse condition of the environment;

2nd. Low temperature and the resulting contraction of the bark with a consequent increase of bark tension; and

3rd. A wind-exposed location so that the bark at the crown or other places of bending of tree trunks or branches is subjected to great strain and consequent excessive evaporation during strong winds.

Such conditions result in loosening or injuring patches of bark, especially on the windward side of trunks and branches of trees which enter the dormant season with incompleted bark-growth or with high bark-tension in regions of bending and strain.

The death of injured or loosened patches of bark seems to be due to isolation and drying out, and it is often immediately followed by further disorganization and decay caused by the entrance of bark fungi like Sphæropsis and Cytospora. The wood underlying

* A reprint of Technical Bulletin No. 23, September, 1912.

winter-injured bark frequently becomes stained by the diffusion into it of some substance apparently originating in the disintegrating protoplasm of the affected tissues after resumption of vegetative activities in early spring, thus giving rise to "black-heart." Often the stained wood is then invaded by hymenomycetous fungi which decay the discolored parts and sometimes portions of unstained wood, thus resulting in "heart-rot."

The different varieties of apple trees often evidenced a marked variation in their relative susceptibility to the initial injury, but once injured they were equally subject to the rotting of the dying parts.

Crown-rot entails a heavy loss among most fruit growers in wind-exposed regions, and whether or not the initial injuries can be avoided remains to be determined. It seems possible, however, that their numbers may be reduced by inducing early and moderate growth in young trees, and by providing windbreaks or some device to keep the trees from swaying in the wind during winter. The observations also suggest that high-headed or severely pruned trees are more susceptible to the initial injuries. If young trees were carefully inspected in spring for evidences of loosened or cleft areas of bark most of the secondary injuries and rots could be prevented by carefully cutting away, at right angles to the surface, all injured bark and applying grafting wax or some good tar paint to the exposed wood.

INTRODUCTION.

Since the publication of a critical summary of the most important available papers dealing with crown-rot[1] and some related subjects most of the time has been devoted to a study of the disease. The field observations made plainly indicate that winter-injury is the first cause of the trouble; and also point to some of the predisposing and environmental conditions resulting in crown-rot. But a histological study of the initial injuries and their further development during the early part of the following vegetative season was deemed necessary for a better understanding of the disease. The field studies are discussed in the present paper while the histological work will be the basis of a subsequent report.

The observations were continued in 1910, 1911, and 1912. Not only the orchards in which the work was started but many others were studied with considerable care, especially during 1910 and 1911. The disease was found to vary much in different parts of the State and also in different orchards of the same locality, but in general it was much like that described in the above preliminary paper and like that found and described by many other investigators.

In these field studies an endeavor was made to find what environmental conditions prevailed in and about affected orchards and which

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[1] Crown-rot, arsenical poisoning and winter-injury.
N. Y. Agrl. Expt. Sta. Tech. Bul. 12:367–411. 1909.

varieties are most subject to the disease. It appeared that certain surroundings and locations are typical of crown-rotted trees, and other things being equal, that the different varieties seemed to possess a rather definite relative liability to the disease. An environment or season which induces the origin or production of tissues that for one reason or another could not be fully matured or differentiated before the close of the vegetative season, seemed to be associated with the occurrence of crown-rot. Whether the completion of growth or full maturation of the tissues is prevented by low temperature or some other untoward conditions such as drought, etc., the net result may be the same. A tree is thus forced into a dormant period of severe environment in an abnormal and susceptible state. The main varietal characteristics that were noticed as distinguishing the more susceptible from other varieties are the habits of rapid growth and early bearing.

Another environmental factor, which in general is noticeably related to the occurrence of crown-rot, is the wind. The relative wind exposure was frequently the only observable difference in the environment of neighboring orchards, one of which was severely affected, the other but little if at all. The direction of the prevailing wind of a locality or its direction during a critical period usually corresponds to the side of maximal injury.

The economic relations of crown-rot are of more consequence than appears at first sight, because the lives of affected trees are involved. In case of diseases of foliage or fruit the damages are largely confined to one season while from this type of disease a loss may be sustained which amounts to several years of time and a considerable outlay of money.

FIELD OBSERVATIONS.

INTRODUCTORY.

During late summer of 1909 a short study was made of a few crown-rotted orchards. The most severely affected trees were easily discerned at a distance by their rather sparse and prematurely yellowing foliage. On examination at close range it was found that such trees had large areas of dead, decaying bark somewhere on the stem, usually at the crown or about the bases of the upper roots. In fact in many such cases the decaying bark completely girdled the crown and in others the bark of all the lateral roots, as well as of the stump, was entirely dead and decayed, thus leaving only a few small roots under the center of the tree intact and available for the absorption of soil solutions. By making numerous cross and longitudinal sections it was found that in many instances both the alburnum and duramen were discolored or even decayed. In these same orchards, however, were apparently normal trees having injuries of the same type sur-

rounded by healthy rolls of callus. But on counting the annual growths in section it became evident that the injuries resulting in the exposure of patches of dead wood on normal looking trees occurred at the same time as those on the dying trees. The difference in the condition of the trees seemed therefore chiefly a matter of difference in the degree or extent of the initial injury.

In the orchards studied in 1909 no affected trees were found which had been injured just preceding that vegetative season; in most cases the initial injury had occurred two or more winters earlier. The assumption that crown-rot is primarily due to winter-injury had therefore not been deduced from observations on recent injuries but rather from the fact that the initial injuries had all occurred *between* the vegetative seasons, and could not on that account be due to mechanical injuries arising during cultivation or to other agents operating in the *growing season;* and also on the wide expanse and often general distribution between two particular seasons' growth, of a discoloration which frequently shows as a complete circle in cross-sections made even at some distance from visible external injuries of a tree trunk. It was during the summer of 1910 while studying a crown-rotted orchard near Coxsackie, N. Y., which had been briefly reported on before, that some early stages of the disease were observed. After examining the bark on the trunks of many normal looking trees, two of the Baldwin variety, which had been set nine years, were found to have complete girdles of dead bark extending downward about 8 to 14 cm. from the surface of the ground, and including the bases of the lateral roots. The wood appeared normal except for the discoloration of the outermost 1 to 3 mm. of the alburnum. Most of the dead bark was loose and slightly decayed, and the usual discolored zone just under the spring's growth extended some distance above any external indication of injury.

OBSERVATIONS DURING 1910.

The main object of the work in 1910 was to find all possible variations in the characters of the disease as it occurs in this State, and at the same time make special note of the environmental conditions, such as type and topography of soil, wind exposure and cultural history of affected orchards. In most cases the varieties and the relative degree they were affected were also recorded. The observations were made during late summer and fall.

Several orchards were studied around Geneva, Junius, Clyde, and along the west shore of Seneca lake; in and around Rochester, Coldwater, Sodus and Oswego; between Seneca and Cayuga lakes, around Branchport on Keuka lake, and about Highland, Milton and Coxsackie in the lower Hudson River valley. Most of the orchards were located by visiting fruit growers who wrote to the Station for information regarding their diseased trees.

The affected orchards near Sodus and those near Coxsackie, in which the work on crown-rot was begun in late summer of 1909, were visited but once in 1910. No additional trees were found affected in the Sodus orchard, but several of the remaining diseased ones had died. In the Coxsackie orchard only the two additional cases described above were found though others may have occurred, since not all of the trees were carefully examined below the surface of the ground. Twenty more of the trees in this orchard, discussed in the previous paper[1] on the subject, were taken out in 1910 and about twenty in 1911. The orchards around Geneva were under more continuous observation during 1910, but few new facts of any significance were obtained from them.

Some Branchport orchards.— The region about Branchport on Keuka lake is principally a grape-growing locality, although many small orchards may be seen there. About 3 miles west of the village is a small orchard of about 300 trees (about 10 acres) which had been set 9 years, 150 Ben Davis and the others Baldwin. The location is uncommonly high and wind-exposed. The soil is rather gravelly; though it seems fertile, for the trees look thrifty. The orchard had been tilled and cropped every year.

Considerable numbers of the trees were more or less severely crown-rotted or dead, the two varieties being apparently about equally affected. Some of the dead trees had been replaced by new ones. They seem to have been injured during the winter of 1908–09, *i. e.*, after they had been set 5 years. Somewhere between 60 and 70 trees had been injured at the same time; and although the more injured ones had thinner rolls of callus, they had the same number of annual growth additions since the occurrence of the injury as were present in the thicker rolls on the less injured trees. This is an unusually high percentage of injured trees.

The dead or decayed bark generally extended only about 2 to 4 cm. above the surface of the ground, and quite often as much as 5 to 6 cm. below ground. Only in the most severe cases were the upper lateral roots decayed, yet most of the injured trees were rather loose and more easily swayed by hand than normal ones. The trees were headed or pruned up rather high.

Twenty-one or more dead and dying trees were taken out in 1911. All of the less injured ones looked practically normal at that time, though small patches of bare wood, surrounded by thick rolls of callus, still gave evidence of the former injury. No additional cases of injury were found in 1911.

About 2 miles south of the above orchard is another small one of some 200 apple trees which had been set 18 years. It consisted of 50 trees each of Baldwin, Ben Davis, and Greening, 25 King and 12 each of Northern Spy and Spitzenburg. The orchard had usually been cultivated and often cropped. It is located nearer the lake and

[1] *L. c.*, p. 391.

has a few acres of forest about 300 m. to the northwest which may give some protection from severe winds in winter. The soil is deeper and less gravelly than in the first orchard described. Only Ben Davis, King, and Spitzenburg had crown-rot. Twelve of the Ben Davis, or 24 per ct., either died or had been more or less severely affected by the disease. No very evident difference could be found between the rigidity or resistance to swaying of the crown-rotted and uninjured trees. Even severely injured trees bore nearly normal crops during 1910, although a few of them died in 1911. No new cases developed in 1911. The rot in this case, as in the previous one, was also just above the ground line. All told, about 6 per ct. of the trees in this orchard were affected with crown-rot.

The Junius orchard.— Not far from Junius, a railway station a few miles north of Geneva, is another ten-acre apple orchard (300 trees, mainly Greening, Baldwin and Northern Spy) which had been set about 15 years. The soil is a sandy loam, lying very high and wind-exposed. The orchard had been cultivated and cropped until 1909.

The rot is often wholly above ground and somewhat canker-like, but in some cases it is just at or below the surface of the soil. Several of the tree trunks have the so-called "sun-scald" injuries on the west or northwest sides, to such an extent as to result in numerous irregular areas where the bare wood is exposed. The crown-rot injuries, when confined to small areas, are frequently also localized on the west and east sides. But it appears that the *distribution of the larger lateral roots has something to do with the localization of the injuries*, as noted in the paper previously cited.[1] The injury inducing the rot on these trees seems to have occurred during the winter of 1908–09.

Nine of the crown-rotted trees, including both Northern Spy and Greening, were either dead or will die soon; while most of the other 25 diseased ones seem to be recovering and will probably survive several seasons. The orchard is growing well and yielding good crops.

The Barnes orchards.— Two orchards were studied on the west side of the southern end of Seneca lake: one had been set about 12 and the other about 20 years. The trees were mostly Baldwin, Ben Davis and Greening, with a less number of Northern Spy. The soil is a rather thin, clay loam, with good drainage. There is no evident protection from the western winter winds. The orchards were plowed once a year and cropped every season.

About 4 per ct. of the trees in both orchards were crown-rotted, but the affected ones among the Ben Davis and Baldwin were more numerous than among Northern Spy and Greening. The initial injury seemed to have occurred during the winter of 1906–07. Most of the rot was several centimeters above the ground, although on a Northern Spy tree an almost complete girdle of exposed, dead wood was found just below the surface of the ground. In another instance

[1] *L. c.*, pp. 390–91.

the bark on all of the upper portion of an old callus, as well as that extending several centimeters above it, was discolored, and had some very small longitudinal clefts from which exuded a discolored "sap." The wood underneath the bark was also blackened to the depth of several millimeters. It could not be definitely determined whether the clefts had resulted from drying of the dead bark or whether they occurred before the bark died. On a portion of the dead bark the periderm was raised to form several blisters which also contained discolored "sap." The bark was not dead throughout its discolored portion, especially toward the upper and lateral limits of the newly injured area; in some places only the outer tissues of it were involved while the inner bark was at least partially living. It looked a little like a case found much later and shown in figure B on Plate XVII. In the younger orchard many of the Baldwin and Ben Davis trees were affected with an irregular scaling off of the periderm on the southwest side of the stems from 5 to 15 cm. above the ground up to the lower branches. The scaling surface was very rough and irregular, and by scraping it with a knife was found to have small groups of dead, brown spots scattered thickly over it and extending almost to the wood.

The Coldwater orchard.— In a medium sized 20-year-old orchard near Coldwater were perhaps a dozen trees having more or less rot at the crown. In this case several Northern Spy trees were practically dead as a result of crown-rot. The land is almost level but the winter winds have a full sweep without obstruction. The soil is very sandy. It was cultivated until recently, but is in sod now.

The rot was almost wholly at or below the surface of the ground, and in several instances only involved the outer bark. In other cases a complete girdle of outer bark sloughed off just below the surface of the ground, leaving a somewhat irregularly pitted or pockmarked surface on the inner bark with a rather uneven cover of regenerated periderm. Two such corroded trees were found on which unevenness of the outer surface of the exposed inner bark was so marked that many of the pits extended to the wood. It seems as though scattered groups of cells in the outer bark had died and on account of their being so close together had become confluent by the dying of living groups between them. In some respects it resembles the distribution of groups of dead cells in cases of mild forms of so-called "sun-scald," above ground, except that in case of the underground injury the abundance of moisture favors a rapid decay of dead groups, and is more favorable to the formation of wound-cork over the outer limit of living tissues.

Maples around Geneva.— During the summer of 1910 many maple trees were found in the parks and streets of Geneva that had some loose bark. Plates XX to XXIII give an idea of the different types; including cases in which long radial clefts accompanied the loosening,

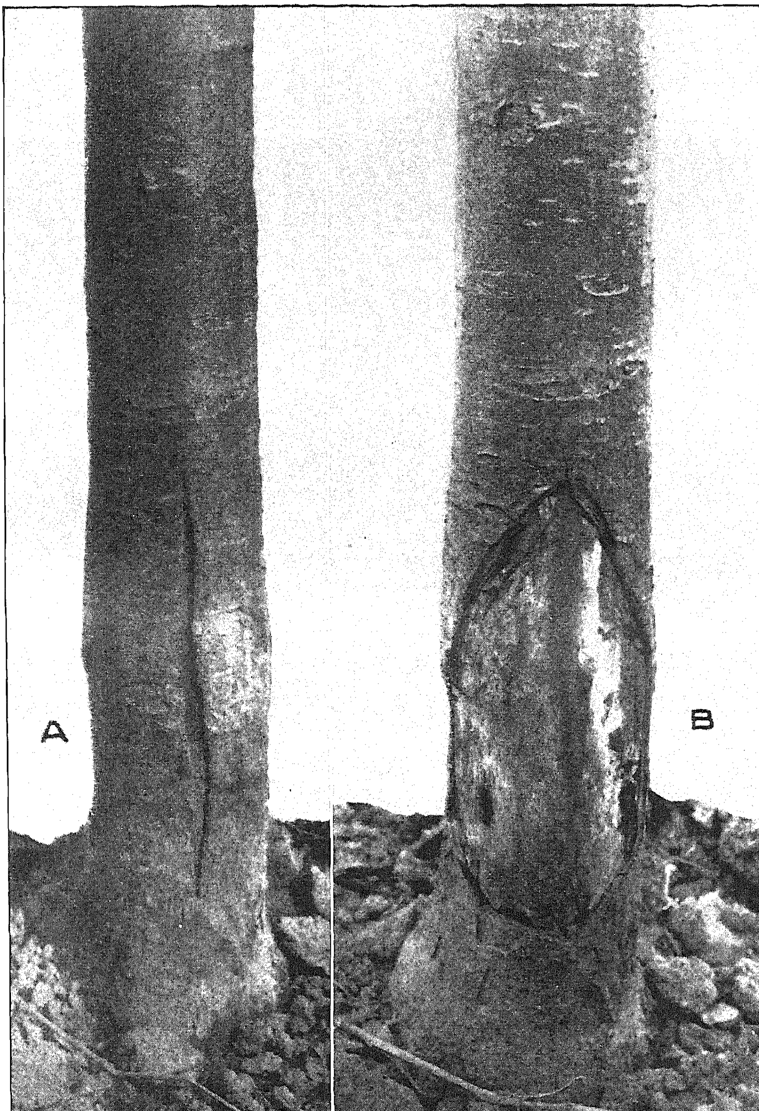

PLATE VII.— STEM OF WINTER-INJURED BISMARCK APPLE TREE.

A, cleft in bark 17 cm. long on northwest side; B, nearer view of A with loosened bark removed.

(Photographed May 7 and 8, 1911.)

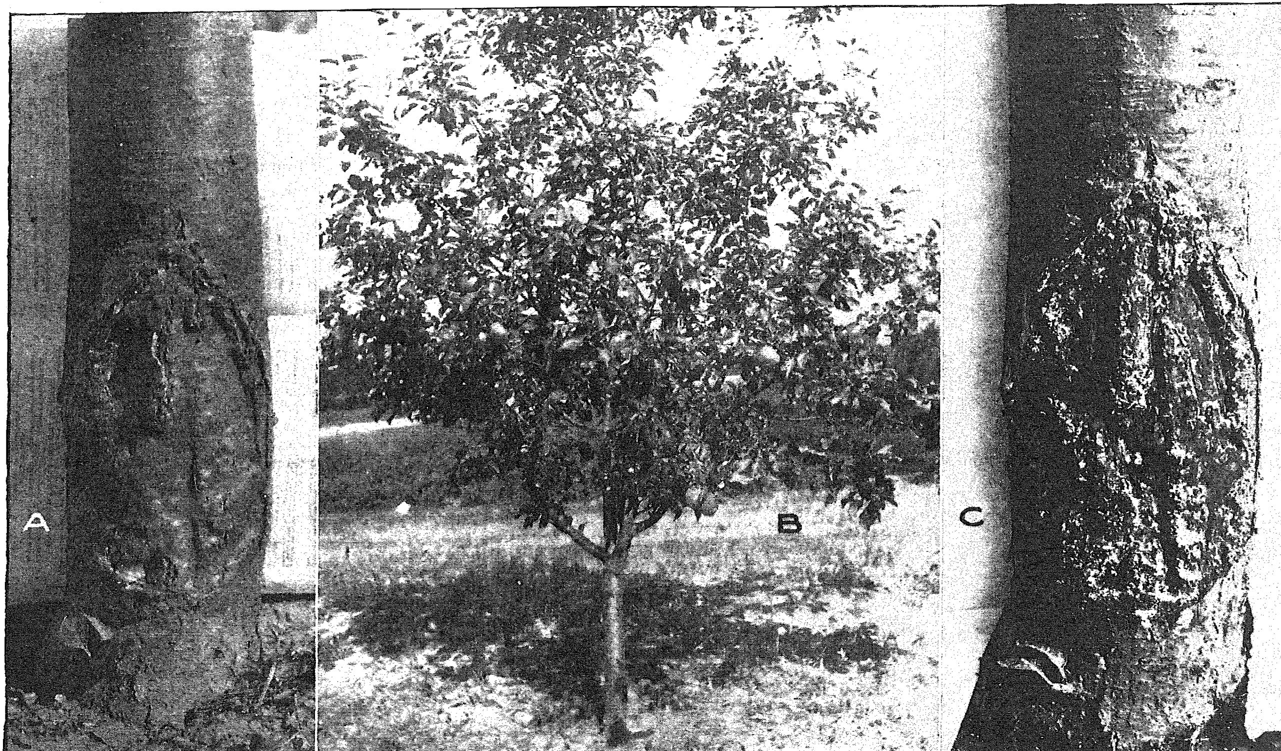

PLATE VIII.— LATER VIEWS OF TREE SHOWN IN PLATE I.

A, wax-covered wound with irregular regeneration bursting th[illegible] wax; B, tree on August 15, 1911; C, grafting wax removed, showing

Plate IX.— Winter-injured Trees from a Clyde Orchard.

A and B, tree before and after removal of loose and dead bark, showing warty nature of regeneration; C and D, extension of injury by subsequent death of bark above externally evident injury; E, practically all injured bark on this tree was loose and dead when photographed June 3, 1911.

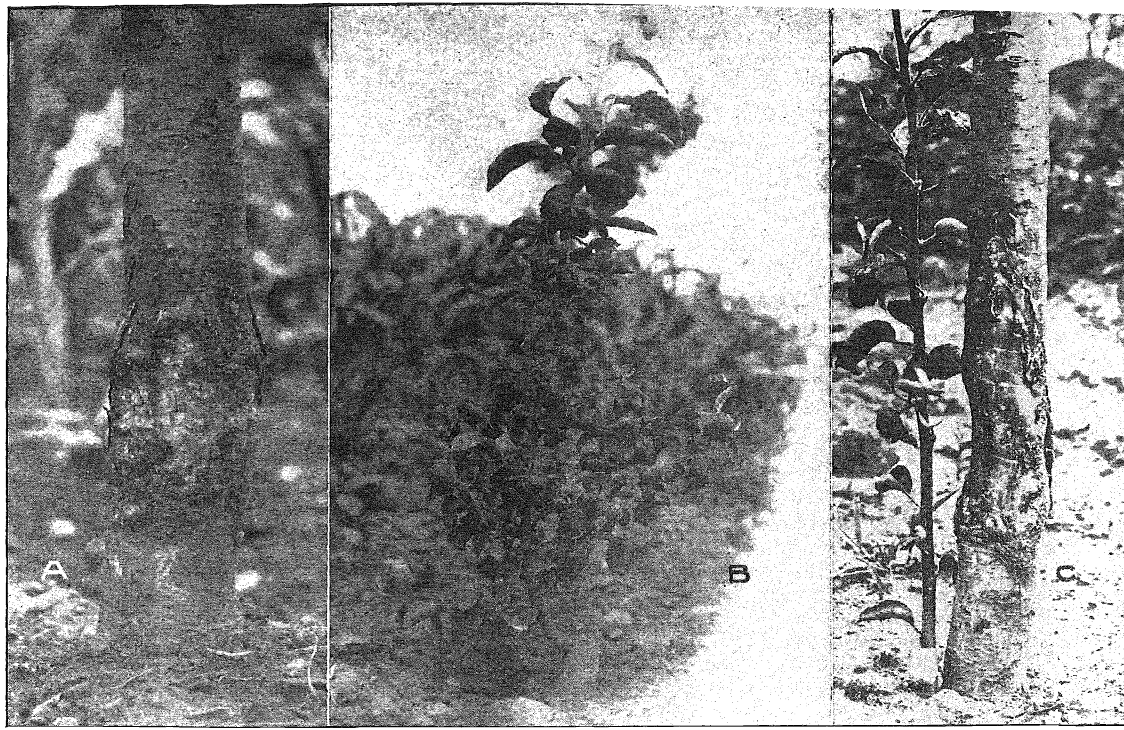

Plate X.— Winter-injured Trees from Clyde Orchard.

A and C, injured bark removed and wood covered with grafting wax; B, stump of girdled tree with sprout grown from it.

(Photographed August 3, 1911.)

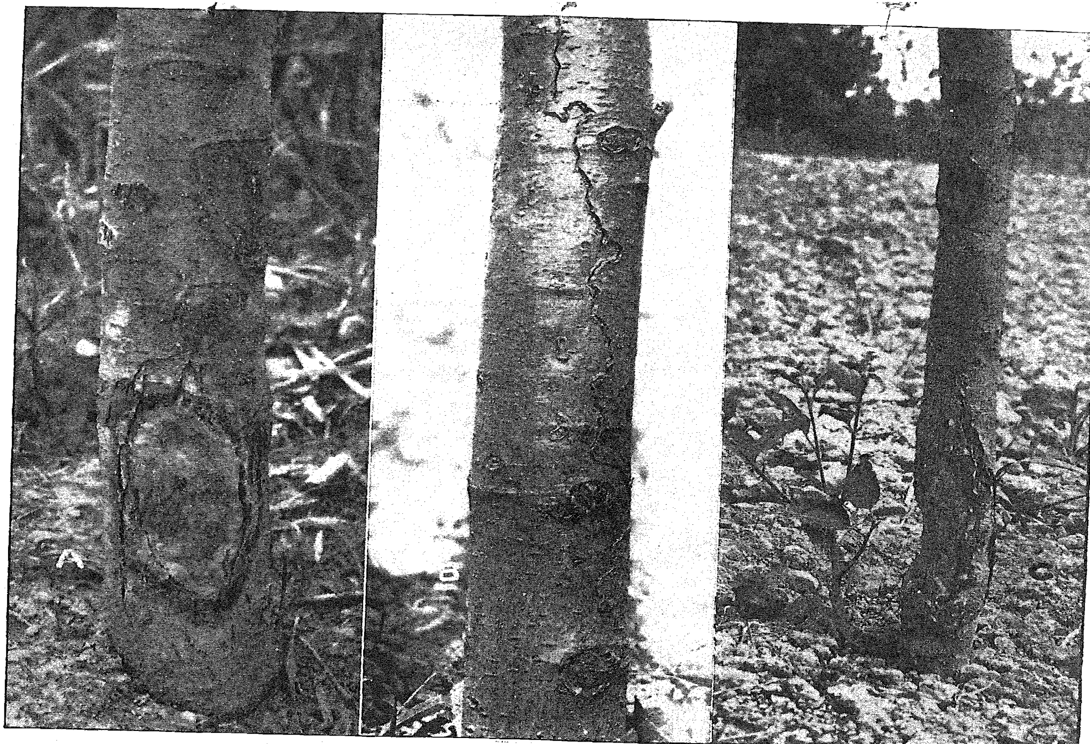

PLATE XI.— WINTER-INJURED APPLE-TREE STEMS FROM CLYDE ORCHARDS.

A, trunk that had been surrounded by veneer protector; B, large depressed area on northwest side, still green-colored on June 18, 1912; C, tree injured in winter of 1910–11, as it appeared on June 18, 1912.

(A, photographed August 3, 1911.)

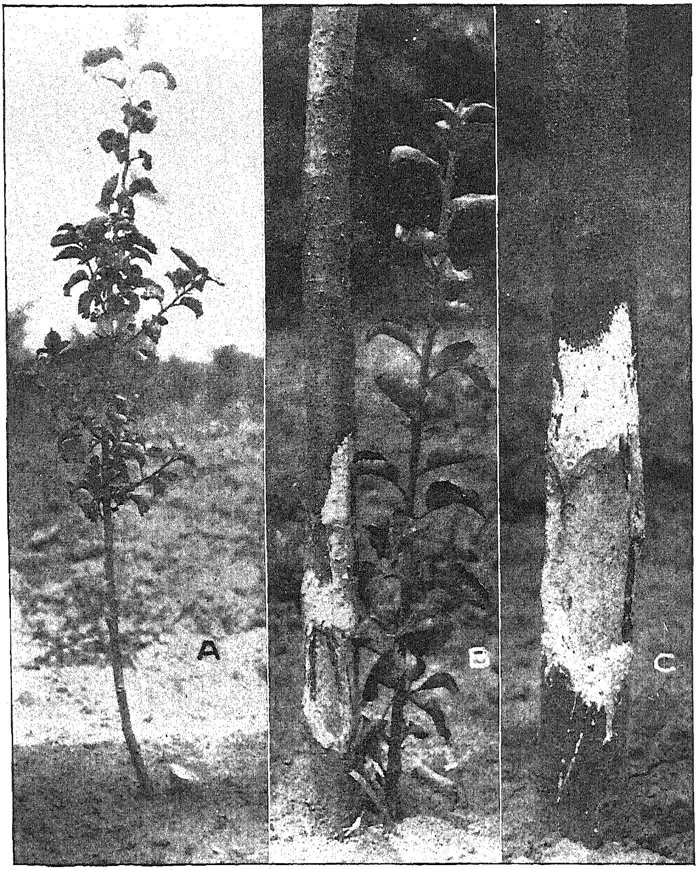

PLATE XII.— WINTER-INJURED TREES FROM WEEDSPORT ORCHARD.

A, sprout grown from Baldwin stump; B and C, stems with exposed wood painted.

(Photographed August 4, 1911.)

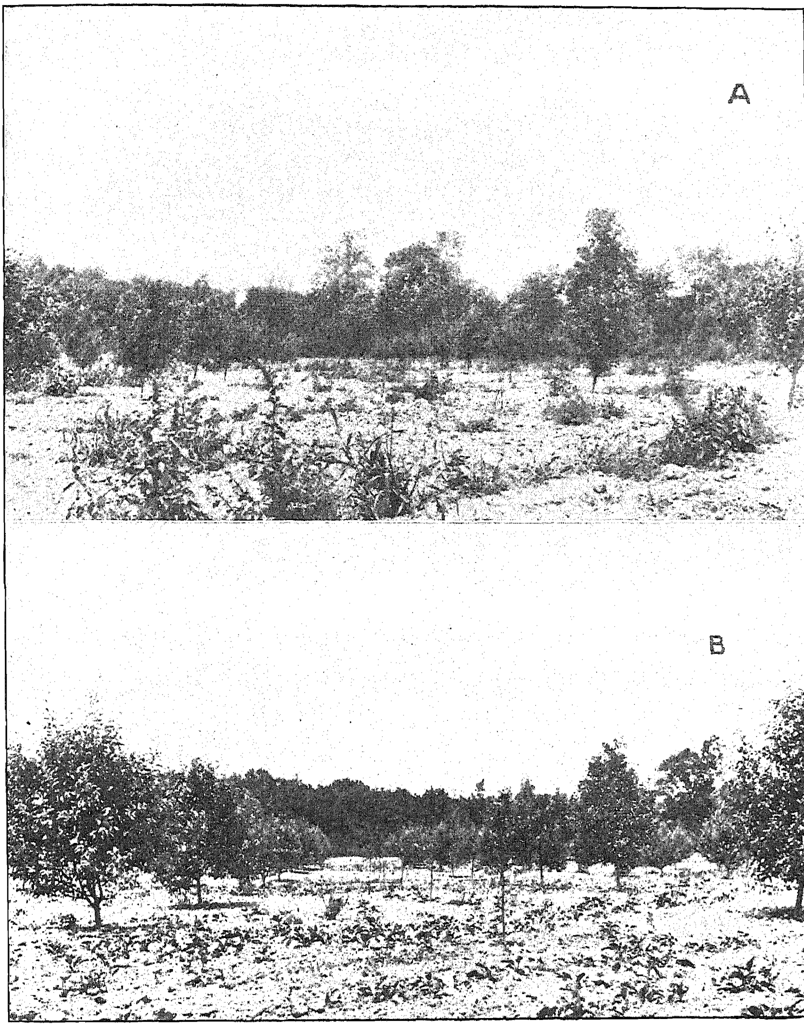

PLATE XIII.— VIEWS IN WEEDSPORT ORCHARD.

A, row of Baldwin in center, Ben Davis on both sides; B, entire row of Baldwin stumps in center replaced by young trees.

(Photographed, A on August 4, 1911, and B on July 23, 1912.)

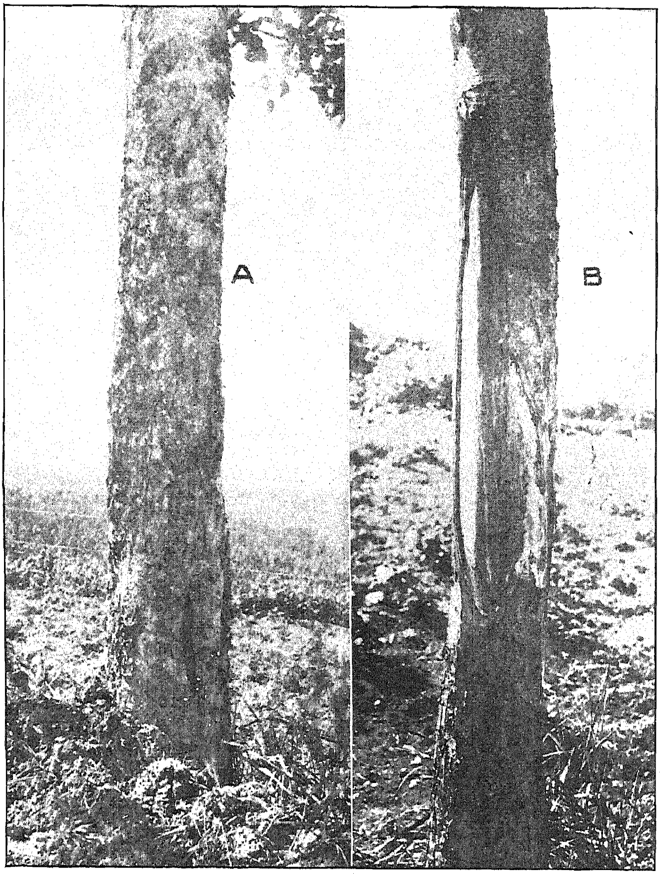

Plate XIV.— Winter-injured Trees from Glens Falls Orchard.

A, tree with short cleft, but girdle of loosened bark extending about half way up to A. B, another tree with loosened bark removed; had been cleft about half its length.

(Photographed June 24, 1911.)

PLATE XV.— WINTER-INJURED TREES FROM ANOTHER GLENS FALLS ORCHARD.

A, tree with about two-thirds of bark loosened from trunk; B, tree with bark cleft about 2.5 dm. long, bark loosened up to lower crotches.

(Photographed June 24, 1911.)

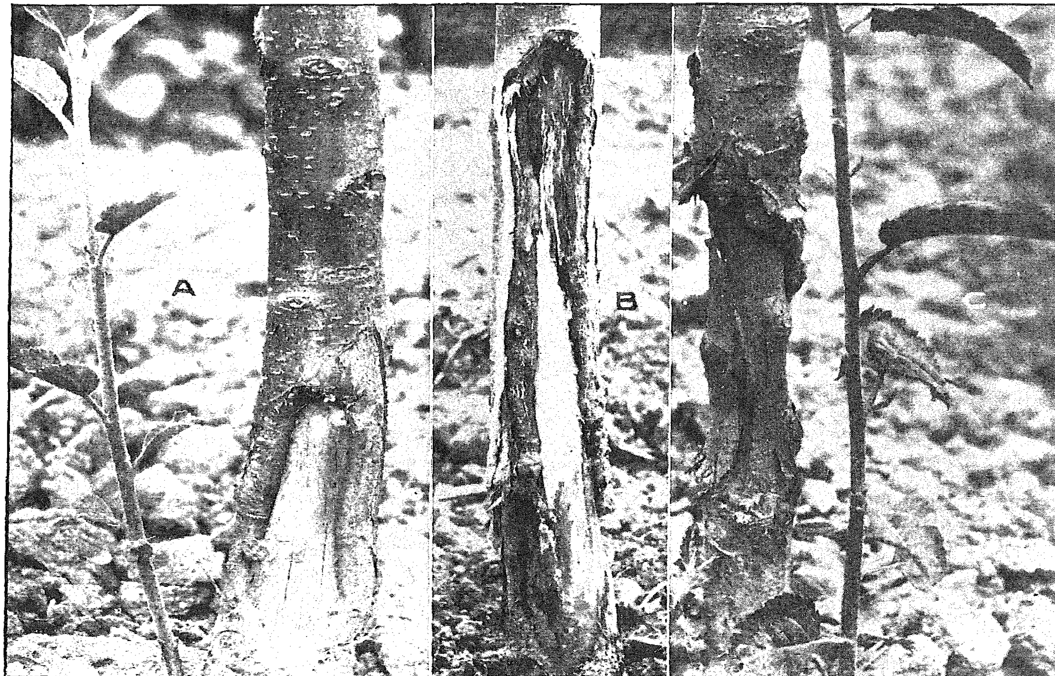

PLATE XVI.— WINTER-INJURED TREES FROM INTERLAKEN ORCHARDS.

A, tree with callus-bordered area of dead wood on south side; B, inadequately cleaned and painted wound; C, tree completely girdled, dead bark partially adhering, thick callus along upper edge of girdle.

(Photographed August 5, 1911.)

PLATE XVII.—WINTER-INJURED TREES FROM LE ROY ORCHARD.

A, bridge grafts at right and left of girdled stem; B, injury resulting from winter of 1910-11, apparently an early stage of the type shown in A.

(Photographed August 7, 1911.)

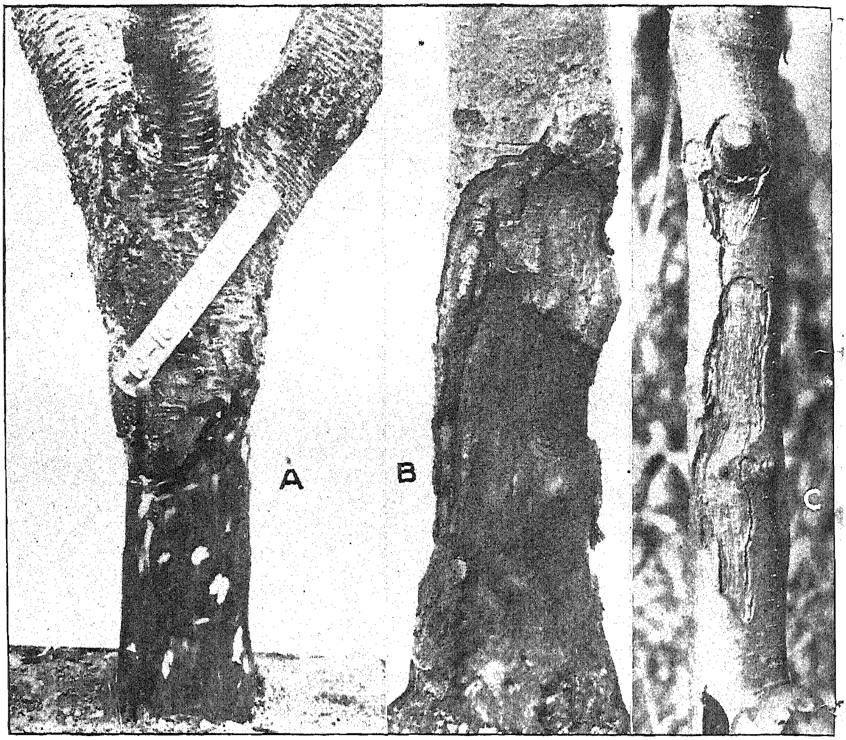

PLATE XVIII.— WINTER-INJURED FRUIT TREES.

A, peach tree with dead girdle of bark removed, showing callus along upper margin; B, typically crown-rotted apple tree, with girdling nearly complete; C, Bartlett pear tree with depressed dead areas where inner bark was severely winter-injured.

(Photographed, AT GENEVA, A on July 5, 1911; B, in August, 1911; at Medina, N. Y., C on August 16, 1911.)

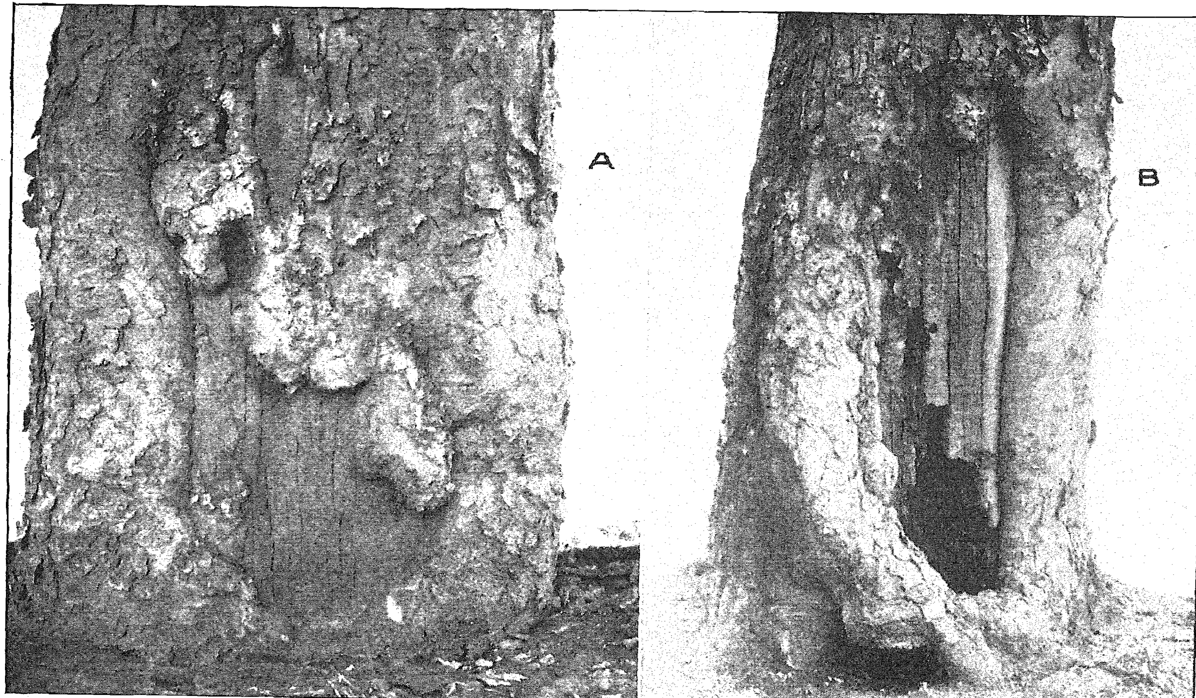

PLATE XIX.— CROWN-ROT SCARS ON OLD APPLE TREES.

A, old wound surrounded by irregular regeneration; with a second injury dating one year after first one showing below at left; B, advanced stage of "heart-rot" following winter-injury.

(Photographed at Geneva, 1911.)

PLATE XX.— *Acer platanoides* INJURED IN WINTER OF 1909–10.

Section of trunk about 25 cm. above ground. Initial injury forms circle with exposed wood. Wood partially decayed by a Polyporus.

(Cut and photographed November 25, 1910.)

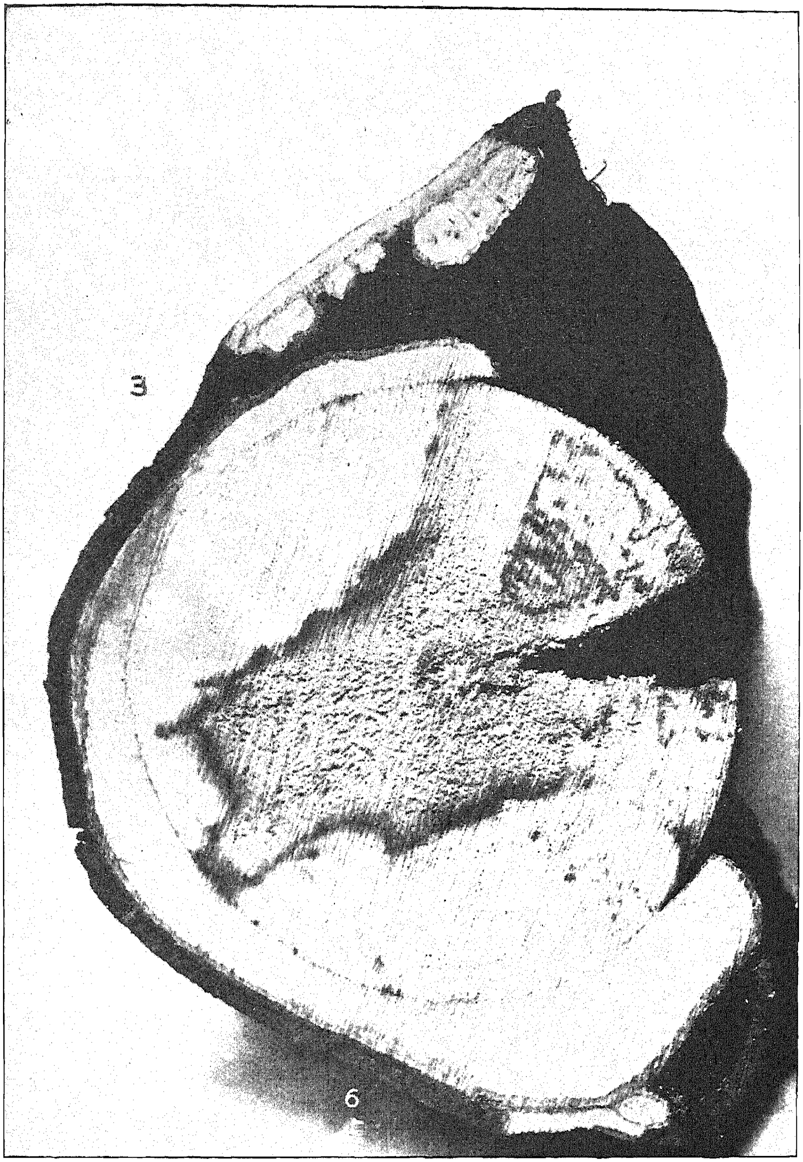

PLATE XXI.— *Acer platanoides* INJURED IN WINTER OF 1909–10.

Section taken 10 cm. above that on Plate XX. Specimen kept in museum from November, 1910, to July, 1912; "heart-rot" progressed; numerous Cytospora pycnidia found on old dead bark at left, between 3 and 6.

(Cut and photographed July 3, 1912.)

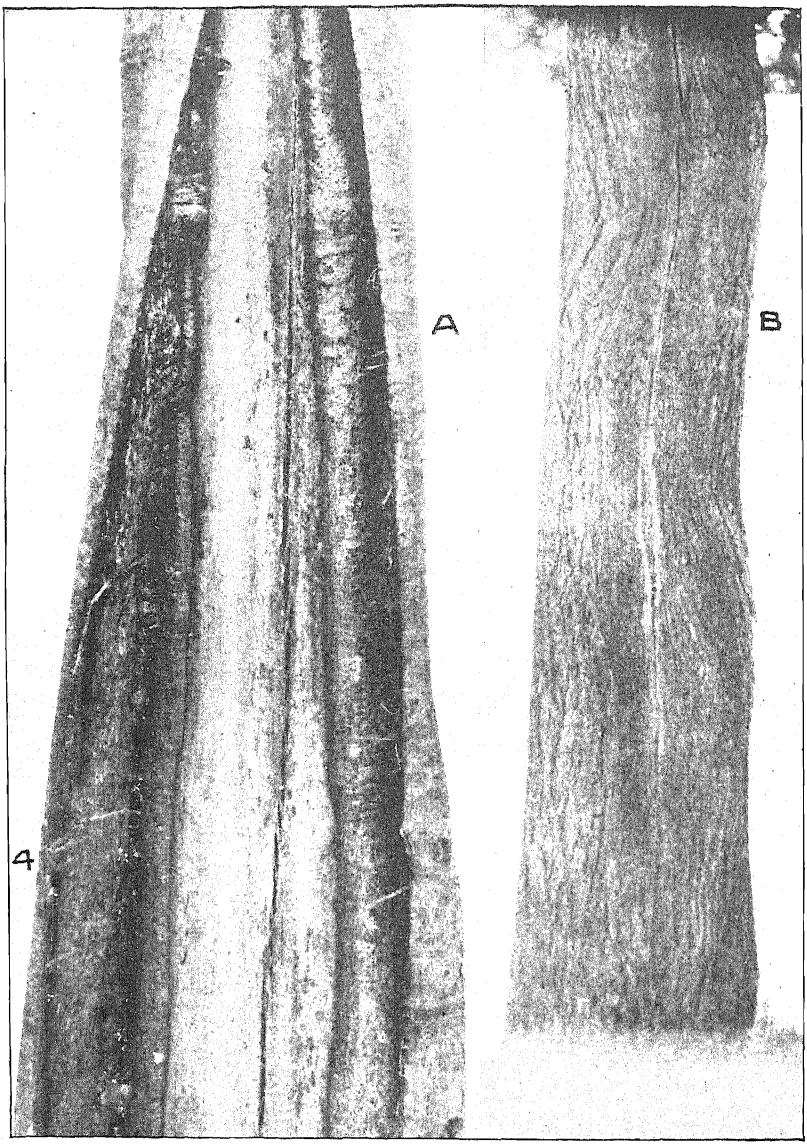

PLATE XXII.—WINTER-INJURED MAPLE TREES.

A, piece of trunk shown in section on Plates XX and XXI; 4, point at which section in Plate XV was cut. B, *Acer platanoides* with closed injury on west side.

(Photographed, A on November 25, 1910; B in 1911.)

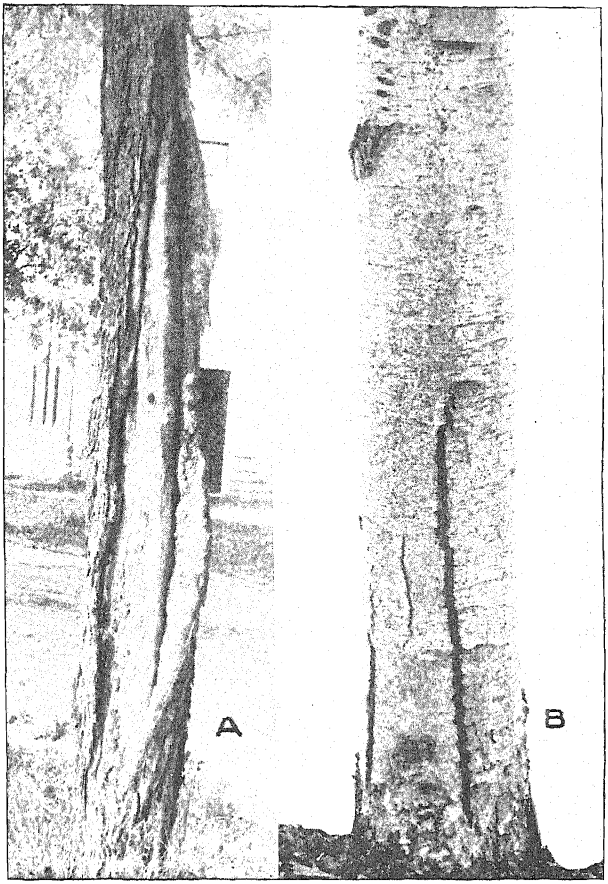

PLATE XXIII.— WINTER-INJURED TREE TRUNKS.

A, *Acer saccharinum* with injury on southwest side, occurring in winter of 1909–10, followed by double regeneration like that shown in Plates XX, XVI B, and XXII; B, apple tree trunk with cleft in bark, from winter of 1910–11.

(Photographed, A on July 2, 1911, and B on July 23, 1911.)

PLATE XXIV.— CROWN-ROTTED SHADE TREES.

A, weeping beech on which initial injury occurred in winter of 1909–10; tree was girdled and died (1911); B, *Acer saccharinum*, 45 years old, affected on northwest side; stands on east and west street.

(Photographed in July, 1911.)

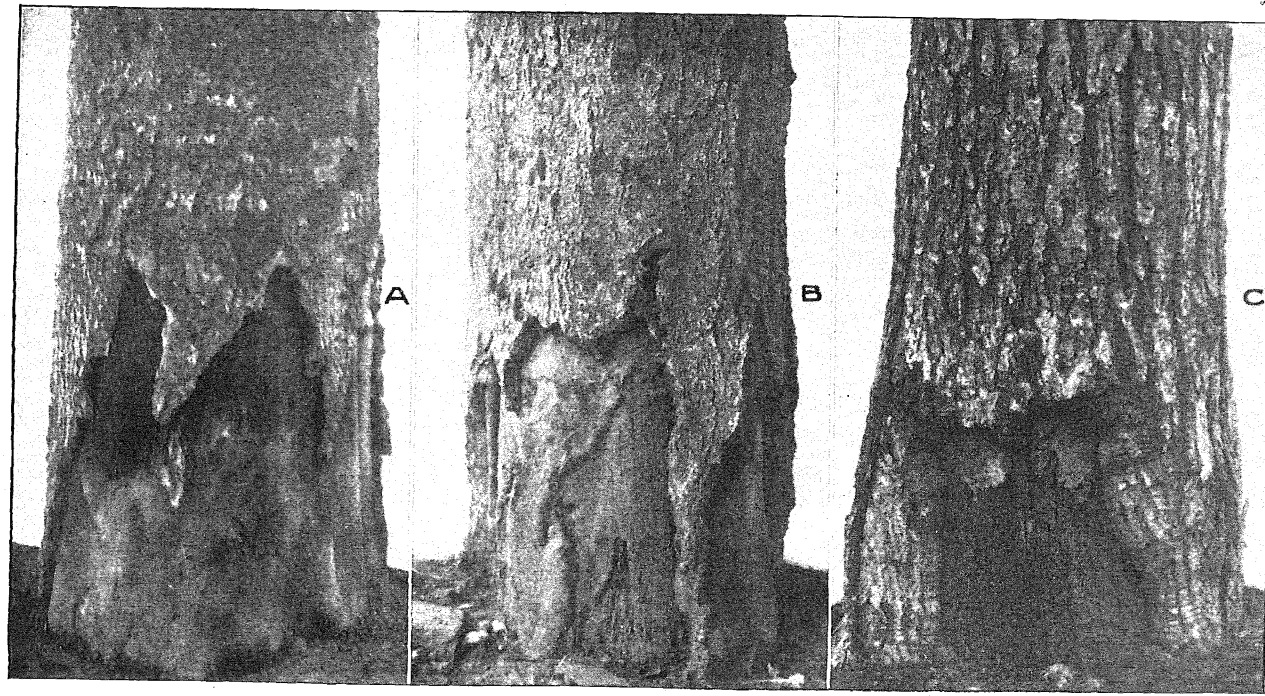

PLATE XXV.— CROWN-ROTTED MAPLE TREE TRUNKS.

A, *Acer platanoides* with injury on west side; stands on an east and west street. B, *Acer platanoides*, showing injury to have taken place in three stages or seasons, on west side of tree on southeast street corner. C, *Acer saccharinum*, affected on south and north sides; failed to leaf out in 1912; stands on northeast street corner.

(All photographed in July, 1911.)

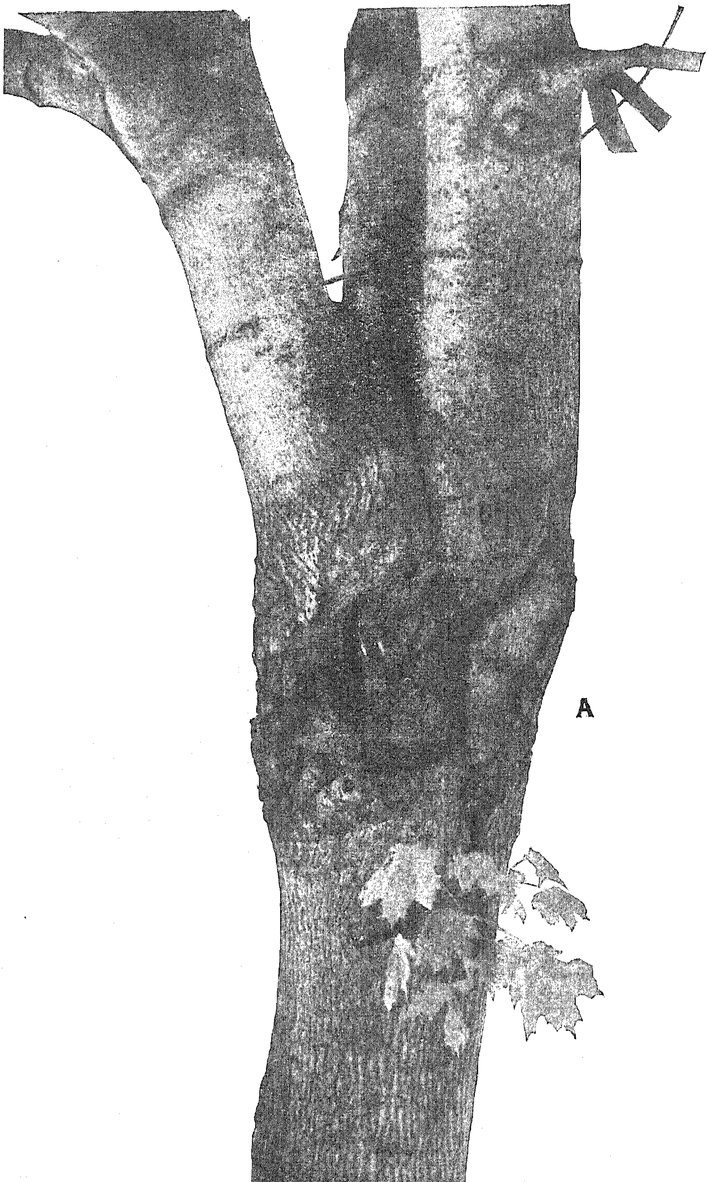

PLATE XXVI.— A COMMON TYPE OF CROTCH CANKER.

Acer platanoides on an east and west street, with canker, A, on east side about 1.7 m. above ground; circumference at twig below canker, 81.3 cm.

(Photographed in July, 1911.)

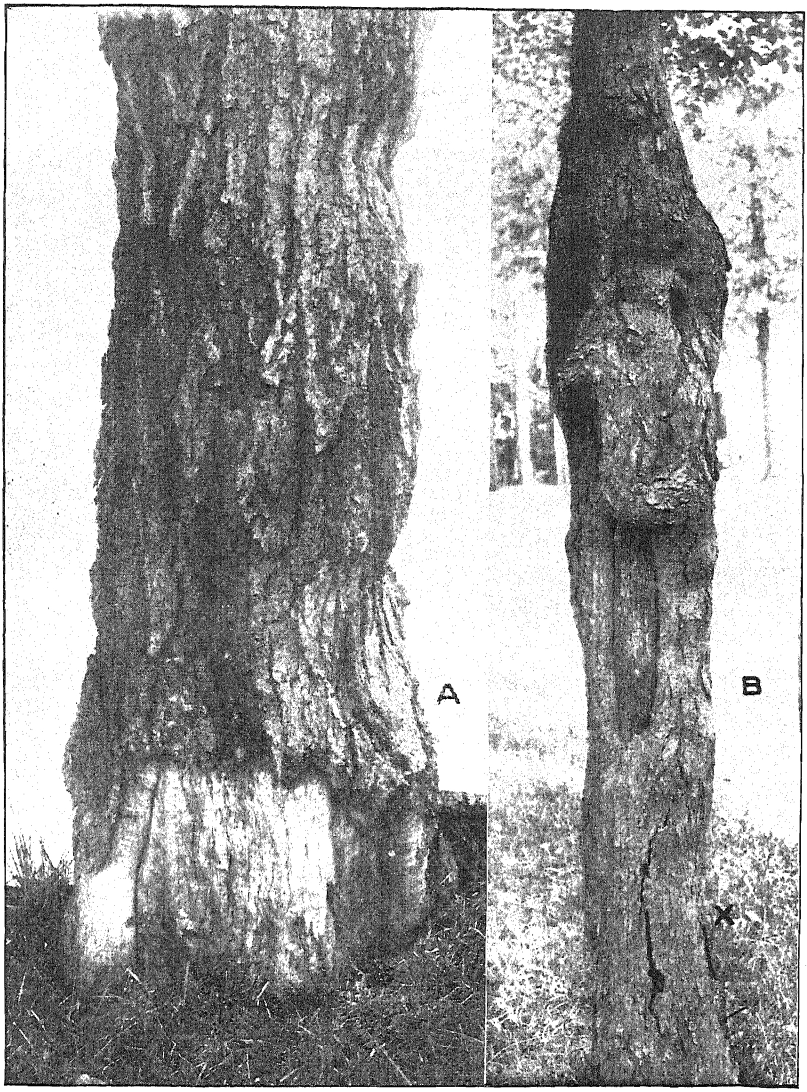

PLATE XXVII.— WINTER-INJURED MAPLE TREE TRUNKS.

A, *Acer saccharinum* in a wind-swept lawn, midway between two large buildings which stand to east and west; injuries occurred on both north and south sides; tree failed to leaf out in 1912. B, *Acer platanoides*, on north and south street, with injury on north side showing double regeneration and exposed wood below; another injury near base (at X) occurred in winter of 1910–11.

(Photographed, A in July, 1911, and B in July, 1912.)

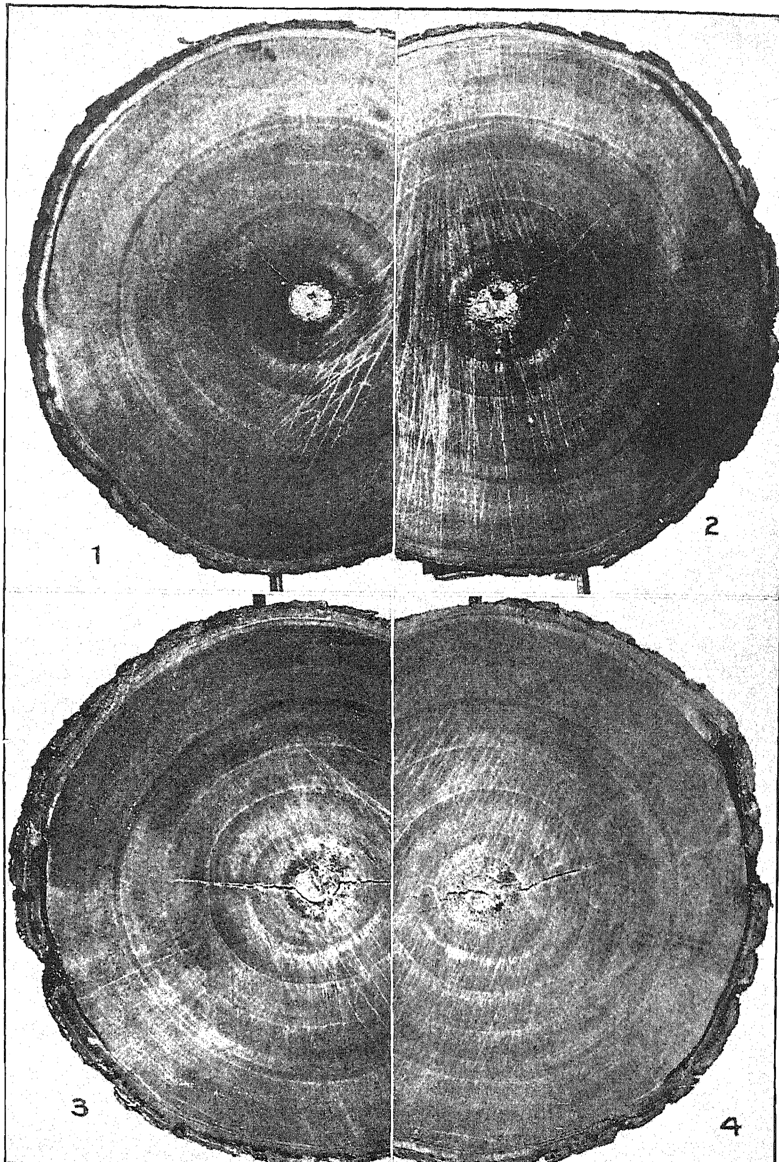

PLATE XXVIII.—SECTIONS OF WINTER-INJURED *Acer Negundo* FROM MADISON, WIS.

1, cut about 15 cm. above ground, loosened bark at left; 2, cut 2.5 cm. above 1, slight cleft in bark and trace of one in wood; 3, cut 2 cm. above 2, clefts more marked; 4, cut 2.5 cm. above 3, loose bark nearly all dead and callus conspicuous.

(Tree cut May 28, 1912; photographs made in Geneva July 25, 1912.)

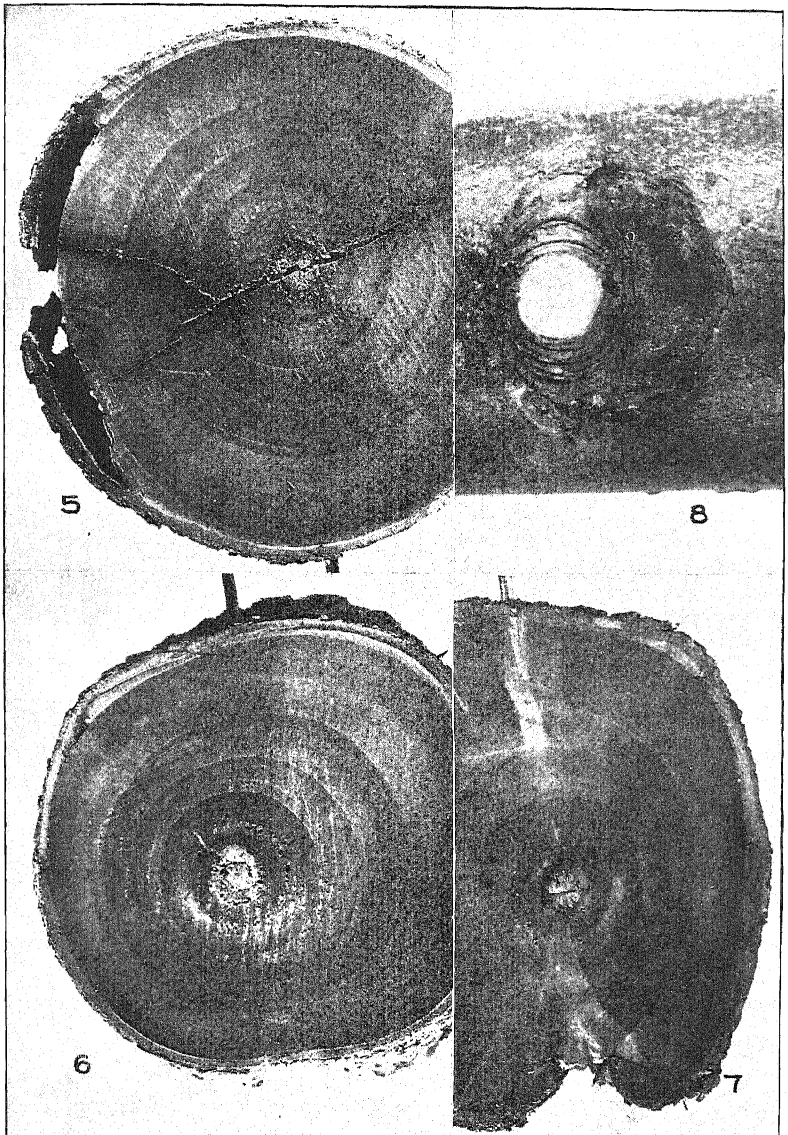

PLATE XXIX.—SECTIONS OF *Acer Negundo*; PIT CANKER ON APPLE BRANCH.

5, cut about 45 cm. above 4, Plate XXVIII, cleft extending through wood; 6, cut about 15 cm. above 5, which is about 1 cm. above upper end of cleft in bark; 7, cut 3.2 cm. above 6, about 5 cm. below first crotches; 8, "pit canker" around hole made by bark beetle (Scolytus) at base of twig on tree frozen artificially in September, 1911.

(Photographed in July, 1912.)

and some where there was apparently only a separation somewhere in the inner phloem with a subsequent dying of the loosened bark.

The most conspicuously affected trees seemed to vary in age from 9 to 15 years, and range from 11 to 18 cm. in diameter. In a small park near the Experiment Station were 12 *Acer platanoides* and 2 *A. saccharinum* trees injured to such an extent as to cause their removal in the fall of 1910.

In these particular cases the injury had occurred during the winter of 1909–10, as evidenced by the fact, shown in cross-sections, that the separation took place *after the close* of the growing season of 1909 and before growth was resumed in 1910. The portion of the tree trunk from 6 to 20 cm. above the ground nearly up to or even including the lower branches, was usually involved. In some instances the clefts in the bark were also accompanied by clefts in the wood, as shown in section in Plate XX. Such clefts in the wood sometimes even extended entirely *through* the cylinder though in most instances they only went to the center or pith. All of the cases of bark loosening in and around Geneva dating back to the winter of 1909–10 were most severe on, and sometimes entirely confined to, the west or southwest sides. Usually there was sufficient injury in the inner bark of the entire circumference of the affected portion to show as a discolored circle in cross-section. On sawing short cross-sections from severely affected portions of a trunk the past season's growth of wood sometimes fell away from the central part of the section, along the discolored line. Usually both surfaces were of a dark brown color, but they were always more or less thickly covered by scattered pin-head-like, white specks. The raised white specks of one surface were found to coincide with those on the other when the pieces were placed together again. Apparently these irregularly scattered white specks were column-like living bridges connecting the wood of 1909 and 1910 through the thin, discolored or dead tissues between the two years' growths. The line of separation was chiefly somewhere in the phloem or the inner bark; but there was evidently much variation in the location of the place of separation, as judged by the differences in the growth and regeneration taking place in 1910.

Some of these matters will become clearer by a study of a cross-section of one of the tree trunks. Plate XX is a section of *Acer platanoides*, taken about 25 cm. above the ground; its shortest diameter is 12 cm. In this case the wood cylinder was cleft into two nearly equal parts near the base, but about a meter higher up the cleft extended only to the pith; and towards the upper limits of the externally visible injury the wood was not cleft at all, although the place of injury is marked by a discolored circle nearly around the whole circumference. Plate XXII, figure A, shows a large piece of the same trunk. On the unpeeled part the bark, although having an unbroken outer surface, is undulating or wavy owing to differences in the rate

of growth at different places. These regions of different growth rate vary from 1 to 3 dm. in length and usually of less width, and are irregularly distributed over the surface of such injured trunks. Many maple-tree trunks may be found most anywhere having such irregularities of surface. Figure B on Plate XXVII is a rather extreme case while that in figure A is very common. Plate XXI is a section of the same tree taken 10 cm. above that of Plate XX or at point 4 on Plate XXII. In comparing these two sections which are only 10 cm. apart, a striking difference is evident, giving some idea of how the unevenness of bark surface may come about. The regions of excessive thickening in this instance are seen to be due to a sort of double regeneration or growth. As may be seen from Plate XX, the injury occurred when the outermost bark, 5, was still attached to the wood surface at 2; as may also be seen by the line of discolored tissue which makes a complete circle with the exposed wood surface. All the growth between 2 and 5 occurred, then, during the summer of 1910. It is evident, too, that in this case the bark and the wood were separated sufficiently by the initial injury to induce the formation of wood tissue and bark on the inner side of the old bark as well as on the outer side of the wood cylinder. At points 1 on this plate the regeneration along the inner side of the old bark failed, resulting in gaps covered by dead bark. In the section taken 10 cm. above this, as shown in Plate XXI, none of the old bark on the left of the figure regenerated, but died. It, however, afforded sufficient protection to the regenerating wood surface to permit that to grow and develop a new bark under the dead one. It seems that the drying effects of the air prevented regeneration on the peeled side. About 15 cm. farther up the trunk, on the side retaining the bark, was a patch about the size of a man's hand where there was a total lack of regeneration of both the wood and bark, thus leaving a much depressed dead area surrounded by living bark. So this gives at least three degrees of difference in the subsequent growth of such a winter-injured tree: places of excessive thickening where a double regeneration occurs, others where the normal rate prevails, and yet others where no growth takes place but where the bark outside the injury dies.

It seems remarkable that "heart-rot" should have begun so soon after the initial injury: apparently nearly a fourth of the *old* wood had been permeated by the mycelium of a fungus. On putting a piece of the wood in a moist chamber an abortive fructification of a Polyporus developed on it in a few weeks. A Cytospora was fruiting all over the patches of dead bark shown on the left of Plate XXI and also on the dead edges of bark shown in figure A of Plate XXI. It is unlikely that the mycelium in the wood belongs to the same fungus as that fruiting on the bark.

The histological studies of such injuries, beginning before growth starts in the spring, and followed far enough into the summer to get

all the stages of regeneration as well as of the dying of the most severely injured bark, will make these matters clearer, and show in more detail how dead or canker-like areas like those shown in figure B on Plate V and figure C of Plate XVIII, develop on many fruit and shade trees.

Quite often the injury on shade trees is also chiefly localized at the crown, as it most frequently is on crown-rotted fruit trees. Numerous street trees in this city, especially maples along windy streets and those at windy street corners, have decayed areas of bark or exposed dead wood at the crown, like the ones shown in Plates XXIV and XXV. The trees shown in figure C of Plate XXV and figure A of Plate XXVII failed to leaf out in 1912. Both also had large dead places just opposite the ones visible on the plates. Sometimes the injury occurs at the main crotches instead of at the ground or on stems between roots and branches, as shown on Plate XXVI, which is of a maple on an east and west street and has an injury on the east side. But in cases of this kind the side to be injured seems usually to be determined by the method of branching, just as the distribution of the upper roots seems to determine the place of injury when it occurs in the region of the root-crotches or crowns, as noted above regarding the localization of crown-rot of fruit trees. But, as will be seen later, when bark injuries result on that portion of the stems between the roots and branches they more constantly occur on the same side of all trees in a given locality, and without regard to the distribution of roots and branches. Usually trees along streets running east and west are more often injured. When both sides of the street are closely built up the injury is nearly always on the west side of the trees, but in very severe cases on the opposite side also. On streets running north and south which are rather windy, the injured places are on the south and north sides of the trees when both sides of the street are built up, but usually on the southwest side when the west side of the street is not built up. The injured trees in the east and west streets are more numerous than in the north and south ones. In other words, it seems as though the severity and direction of the winds have some relation to the occurrence of the injury.

The park referred to above, in which so many maples were injured during the winter of 1909–10, is located on a height of land at the northwest edge of the city and is notorious for its severe west and southwest winter winds. The trees were firmly rooted in heavy deep soil, and were far enough apart to have sufficient room for rapid growth. From cross-sections it is readily seen that growth had been very good.

A Trumansburg orchard.— A short distance northeast from Trumansburg, not far from the west shore of Cayuga lake, is a small apple orchard which is shielded from the north winds by a large peach orchard but has no protection on the west and south. The soil is a clay loam, with gravelly subsoil, and contains much humus.

The trees are chiefly Ben Davis, Hubbardston, and Northern Spy, which had been set 12 years and were uncommonly large for that age. They have had clean cultivation every year. Along a roadside fence on the east is a row of Ben Davis trees in sod that had been set 17 years, but which were not quite as large as those in the orchard set only 12 years.

On November 1, 1910, a dozen trees of the 12-year-old orchard had been taken out because they were practically dead from crown-rot; and 22 more were more or less severely affected, while the remaining 65 trees in the orchard were apparently uninjured. Most of the dead and injured ones were Ben Davis although a few Hubbardstons were also affected. Those dying in 1910 and the normal looking ones having crown-rot seemed to have been injured during the winter of 1908–09. The diseased trees and gaps were much more numerous in the two west-end rows, although they were scattered throughout the orchard. The Ben Davis trees were usually injured just above the ground, while two Hubbardstons were found having almost complete girdles of dead bark underground, around the bases of the uppermost lateral roots. The injured Hubbardstons did not stand very firm but the affected Ben Davis trees apparently stood as firm as the uninjured ones. Even at this late date (November 1) one could pick out some of the injured trees by the difference in the color of their foliage.

The rolls of callus around the old wounds were uncommonly thick on the less injured trees, while on those dying in 1910 the growth of the past season had been but little.

Here is another instance where the rapidity of growth seems to be related to the occurrence of the initial injury. Like some instances discussed in the above cited paper, trees growing slowly or in sod are apparently less subject to this disease. The row of Ben Davis trees in the sod along the fence, and growing so slow that the 12-year-old trees under cultivation were even larger, had not been affected. However, when judged by the production of fruit the cultivated trees were more profitable.

OBSERVATIONS DURING 1911.

Since the observations in 1910 resulted in broadening the concept crown-rot, and suggested several environmental conditions which appear to be implicated or to co-operate in the production of the disease, it seemed desirable to obtain more definite information during 1911 concerning the details and range of variation of the initial injuries.

During 1911 orchards were studied around Geneva, Medina, Weedsport, Clyde, Branchport, Middlesex, Hemlock, Milton, Glens Falls, Le Roy, Interlaken and Sodus.

Occasional night frosts usually do not defoliate the common deciduous trees of this region in autumn. In normal seasons vegetative activities of our trees cease about the latter part of October; yet apple trees may retain their foliage until the latter part of November, if the rainfall has been considerable during the months of August and September.

Göppert[1] gives the vegetative season or rather the time between the appearance and fall of the leaves of pear and apple as 184 days.

In general it may be said that the conditions were very good for vigorous and late growth in the fall of 1910. The rainfall in August and September were 138.9 mm. and 83.6 mm. respectively, while the averages[2] for those months from 1882 to 1910 are only 96.5 mm. and 55.1 mm. The temperature was also conducive to late fall growth. The averages in 1910 for September, October and November were 17.3° C., 12.7° C., and 2° C.; while the monthly averages of those months for the years 1882–1910 inclusive are 17° C., 10° C., and 3.7° C. respectively. It is thus seen that the temperature for September and October in 1910 was above the 29-year average for those months, and that the November temperature fell below the general average for that month. To sum up, then, the temperature and rainfall during August and September were above normal in 1910, and the temperature in November was below the normal. In fact, the general impression prevailed that wintery weather began about November 12 instead of the latter part of December and continued cold into the early part of January, 1911, when it unexpectedly thawed during terrific west and southwest winds which lasted several days.

It was during the latter part of this warm period in January that winter-injury was found to have occurred quite commonly on fruit trees in the western part of the State. The inner bark and very often parts of the cortex, medullary rays and pith of stems and ascending branches of young apple, cherry, peach, pear, plum, and other trees were found much discolored in spots. Some complaints and requests for advice from fruit growers also came to the Station regarding the discoloration evident on the west or southwest sides of trunks and branches of young pear and apple trees or on smooth-barked, upright branches of older pear trees.

Some Medina orchards.— While visiting some such winter-injured pear orchards near Medina, N. Y., on January 17, 1911, quite a number of young apple trees were found which had loose bark on the stems at the ground. The finding of one or more short and very narrow clefts in the bark of the crowns led to the discovery. The loose bark was living and normal in every way, except that there was a faint brownish discoloration along its inner side and slightly more along the radial cleft. The separation had apparently occurred in the phloem or just outside the cambial region in most cases; but two were found on which the separation had occurred in the cortex, so that

[1] Page 269 of his monograph cited on page 296.
[2] From meteorological records kept at this Station.

only the periderm with some adhering green cortical parenchyma was loose. The loose patches of bark were mostly on the west, northwest, and southwest sides, and their length or vertical extension usually exceeded that of the clefts by 3 to 10 cm., *i. e.*, it seemed that the formation of radial clefts in the bark need not necessarily accompany tangential ones or bark loosening.

These trees were of the Baldwin variety and had been set 2 years; the rows alternated with rows of Bartlett pears, set the same length of time. About 80 per ct. of the pear trees had become severely winter-injured. The soil is a sandy loam, lies rather high in a comparatively flat country with no wind protection on the west. The orchard had been cultivated and cropped to cabbages, tomatoes, etc.

Diagonally across the road to the northeast of this orchard is a smaller Bartlett pear orchard of the same age, condition and culture; but which has a dense old apple orchard on its east side. The bark of quite a number of the pear tree trunks and larger branches was blackened on the west side. But only about 20 per ct. of them were severely injured. Along the east side of the above old apple orchard is another two-year-old Bartlett pear orchard under the same cultural and soil conditions but having only about 1 to 2 per ct. of the trees severely winter-injured, and nearly all of those were in the south end of the orchard which extends some 50 meters farther south than the apple orchard, along the east side of a barn lot. The most severely injured trees were in the portion of this southern extension just east of the gap between the old apple orchard and the barn.

There seems to be no doubt but that the direction of very high winds at certain times during the winter has a relation to the production and therefore to the localization of this type of winter-injury as well as to the type resulting in crown-rot. In this case both types of injury probably occurred sometime between the first of November, 1910, and the middle of January, 1911; for at the time of the last field work in late October no such injuries were found about Geneva and a number of other places visited during the latter part of the month. The detailed discussion of these injuries can more profitably be taken up in connection with the histological studies of crown-rot.

On April 4 another visit was made to the Medina orchards to study the further development or changes that had taken place in the winter-injured trees. The clefts in the loose bark of the Baldwin trees mentioned above had become slightly longer and considerably wider. In two instances the bark had died over about one-half the loosened area, amounting to about a fourth of the circumference of the tree, but in most cases the loose bark was yet living to within about 2 mm. of the radial clefts and with but very little additional browning on its inner side. But the wood of the stems exposed by the clefts had become more browned. The fruit grower was advised to remove all the loose bark with a sharp knife by cutting it out at right angles to the surface, and then

covering the exposed wood with grafting wax. While removing the bark it was found that in cases where it had been in close contact with the wood, the latter was often stained dark on the surface of contact with the bark.

Two of the Bartlett pear trees along the road were also found to have patches of loose bark to the extent of about a third the circumference and 5 to 10 cm. high on the west side of the trunk, at the surface of the ground. One of the injured trees had a loose, tin sleeve about 35 cm. high, surrounding the basal end of its trunk as a protection from rodents. The bark had not only died about the narrow clefts, but nearly all of it that was loose had died and the wood underneath had become stained black to the depth of about a millimeter.

Some Geneva orchards.— About a mile west of Geneva is a small young apple orchard, set 5 years to alternate trees of the Bismarck and Baldwin varieties. The orchard is just south of an east and west road in a slight depression which drains to the north, and just east of a farmhouse and numerous other windbreaks. However, there is no windbreak on the northwest, or on the north side of the road where the land is lower. The orchard was cultivated every year and the trees had grown very rapidly. Conical mounds of soil, to the height of about 15 cm., had been heaped about the crown of the trees in the fall of 1910, and left there until the latter part of April, 1911.

When the orchard was examined on May 6, 1911, for winter-injury four trees (1 Baldwin and 3 Bismarck) were found having loose patches of bark on their stems just above the ground. Two of the Bismarck variety had only the periderm with some adhering cortical parenchyma loosened on the west side over an area extending about one-third round the trunk and 10 to 15 cm. high. On removal of the dead periderm the exposed cortical parenchyma had a very uneven, corky surface; and at the line of radial rupture of the periderm the bark had died practically to the wood. On a Baldwin and on a Bismarck tree some bark was loosened on the northwest and east sides, beginning above the ground and extending upward. The loosened patches were cleft longitudinally, nearly their entire length. The edges of the cleft bark stood several millimeters apart in the middle and were much browned. The wood exposed through the crack and that immediately under the edges of the bark was also brown and dead on the surface; but back under the loose bark it had a white glistening surface with a sprinkling of small brownish specks somewhat unequally distributed. The inner side of the bark had a similar appearance in the case of the Bismarck tree.

The above Baldwin tree with loose bark had a cleft about 6 cm. long on the northwest side and stood open about 4 mm. A crescent-shaped piece of the loose bark 5 cm. long and 2 cm. wide in the middle had died and become dry on the south side of the cleft, but along the

other side of the cleft it had died back only about 4 mm. from the cleft edge.

The Bismarck tree referred to above had a radial cleft in the loose bark on the northwest side 17 cm. long, and another 7 cm. long in a loose patch opposite the large one. The edges of the larger cleft stood apart 6 to 7 mm. in the middle, and the bark had died back about 6 to 10 mm. on both sides of the crack. Figure A on Plate VII is a photograph of this tree trunk, taken May 7, 1911. Without moving the camera all the loose bark was removed and the tree re-photographed; but the negative was spoiled, and therefore another was made the next day. As may be seen from figure B the camera was a little closer, although an attempt was made to set the tripod legs into the same holes they had occupied when figure A was made. A number of very fine wind-checks are also noticeable on the exposed surface.

These figures show that the cleft did not extend to the ground, although it went several centimeters below the surface of the conical mound of soil which had been heaped about the tree during winter. The lower end of the shorter cleft, on the opposite side of the trunk, *began* at the same height as the lower end of this cleft. The longer cleft extended practically the entire length of the loose patch of bark. On May 7, the tree measured 23.5 cm. in circumference. After removing all the loose bark on both sides of the trunk only two narrow bands of adhering bark were left between them. That on the northeast side measured 3.75 cm. and the one on the southwest only 2 cm., thus leaving a quarter of the bark adhering to the wood as bridges.

The loose bark was alive except along the margin of the cleft, and seemed to have increased slightly in thickness, for its inner surface was greyish white and glistened like a regenerating surface. The exposed wood surface had a similar appearance except that an irregular, band-like region, exposed to the air by the crack in the bark, was brown; and that a few other brownish spots were scattered irregularly over the other portions of it. But, even though this wood surface was exposed to the air about 24 hours before being covered with grafting wax, considerable regeneration occurred later, as shown in figure A of the next plate, by the bursting of the wax cover (August 15). On September 11 the wax was carefully removed to determine the amount and appearance of the regeneration which had occurred. Figure C of Plate VIII shows that a narrow strip of wood surface exposed by the cleft as well as various other places failed to regenerate or did so only partially. At that time the tree measured 28 cm. in circumference. The bridging band of bark on the southwest side had increased to about 5.5 cm. in width by lateral growth, and that on the northeast side to about 8 to 9 cm., although its lateral limits were not easily made out on account of the almost perfect regeneration taking place on the adjoining surface of exposed wood.

Figure B on Plate VIII shows that the tree looked normal in every way. In fact it was impossible to tell any difference either in the growth, fruitfulness or color, between this and other trees of the same variety in the orchard.

Across a little ravine on the east of this orchard is another small apple orchard which had been set 7 years and cultivated regularly. About 6 out of each hundred trees were affected by crown-rot, as shown in figure B on Plate XVIII. Three of the trees died in 1911 and several had died the year before. The initial injury occurred during the winter of 1908–09, as indicated by cross-sections through the affected trees.

Sometimes radial clefts occur in the bark of apple and other trees when in reality it is loosened but little, or not at all. In the case shown in figure B on Plate XXIII a cleft occurred during the winter of 1910–11 but no loosening of the bark had taken place. In such instances it appears as though the normal maximum bark tension occurring just before normal bark roughening or scaling begins is sufficiently increased by low temperature to result in abnormal ruptures.

The Weedsport orchards.— A short distance northwest of Weedsport is a 7-acre apple orchard 5.5 acres of which had been set to Baldwin trees in spring of 1909, with Ben Davis as fillers; *i. e.*, with trees of Baldwin and Ben Davis alternating in each row. The other 1.5 acres was set at the same time to a mixture of Northern Spy, Wealthy, and other varieties. The orchard is on high land draining toward the southwest, but has a rather dense low growth of forest on the west which also has a scattering extension on the north around the west end of the orchard, as shown in figures A and B on Plate XIII. The south side, however, is wholly open and fully exposed to the south and southwest winds.

The whole orchard was thoroughly fertilized and cultivated without being cropped. The trees were banked with soil in the fall of 1910, which was removed in spring of 1911. The Baldwin trees had been *headed high* while the Ben Davis trees were pruned but little.

The first visit was made to the place May 18, 1911, when it was found that about 85 per ct. of the Baldwin trees had girdles of dead or dying bark about their trunks, usually beginning 6 to 10 cm. above the ground and extending upward 10 to 18 cm. Apparently, then, the injury occurred about the upper surface of the soil mounds as it did in the orchard near Geneva, discussed above. The clefts in the bark were usually on the southwest or south sides, but on account of the fact that the bark of many of the injured girdles had already died and become dry and wind-checked in various places, it was impossible always to distinguish between primary and secondary cracks. Unfortunately none of the dozen films exposed during this visit proved good enough for reproduction, but the injured places

looked much like those shown on Plate IX with much of the regeneration left out.

In some cases, however, considerable growth and regeneration had occurred resulting in much unevenness in the bark; while in others large areas of bark were only partially loosened, having no radial clefts and still having a green color externally. Such loosened bark had a rusty brown color with a sprinkling of glistening white pinhead-like specks on the side which had been in contact with the wood. A closer study of the inner surfaces of such pieces of bark and of the wood surfaces from which they were taken plainly showed that the white specks of one corresponded exactly with those on the other. It looked as though the bark had not been entirely separated from the wood, but that here and there living groups of cells still maintained a connection between bark and wood. The injury and separation had occurred in the phloem region. In very many other cases carefully examined, such partially adhering areas of bark were nearly dead throughout and there was considerable brownish slime between the bark and wood with still an indication (at intervals) of glistening white specks indicating a living connection at a few points. But the wood had become discolored to the depth of 2 to 12 mm. under such areas.

In many instances, however, the whole of the bark had died, become wind-checked and parts of it stood out from the smooth wood surface. In general, on trees where the bark had been nearly or entirely loosened it had apparently been dead for some time, and there had been little or no staining of the wood beyond the outermost 1 to 3 mm.; while in the cases where the bark had been only partially separated from the wood it was usually yet partially alive and the wood underneath was stained more or less.

The most remarkable feature about this case is the fact that although receiving the same treatment in every way except in the matter of pruning, there is such a great difference here between the Ben Davis and the Baldwin varieties as regards their susceptibility to the injury. In all the orchards studied before, these varieties were not found so markedly different in their relative resistance, while in this case the Ben Davis trees were wholly immune and the Baldwins nearly all injured more or less. Since no difference could be found in the environment or cultivation of the trees it seems legitimate to infer that the above mentioned difference in the pruning of the two varieties may have had some relation to the occurrence of the injury; that is, the high-headed trees were injured while the low-headed ones remained normal.

The Northern Spy, Wealthy and other varieties referred to above had only a few trees among them slightly affected, and they were mostly of the Wealthy variety.

The fruit grower was advised to cut off, below the dead region, all the trees which were entirely or almost entirely girdled and cover

the cut end with grafting wax or paint; and then to select the best sprout for a tree and recut the projecting stub close to it to make the least possible bend in the resulting trunk. It was advised to cut out all loose or injured bark of trees having as much as a third of the circumference of intact bark and to paint the exposed wood to prevent the entrance of water and decay.

On August 4 the orchard had a different appearance. It seemed as though it were a most excellent orchard of Ben Davis with a few scrubby Baldwin trees and sprouts scattered through it. Figure A on Plate XIII is taken down a diagonal row of Baldwins or where they should have been, and to the right and left the Ben Davis rows are seen to look thrifty. In the foreground is a Baldwin sprout, and farther down the row are two Baldwin trees with splashes of white paint covering some exposed wood on the south side. The injured Baldwin trees grew but little and their foliage was rather sparse. A closer view of an injured one is shown in figure C on Plate XII, which was taken on the above date. Figure B of the same plate shows another one which had given rise to a thrifty sprout, apparently due to the poor water conduction of the injured trunk. Most of the sprouts on the stumps had made a good growth, but a strong wind storm a few days before had broken off many of them. The appearance of the sprouts and the manner of cutting off the tree are shown in figure A of Plate XII.

At the time of the first visit to the above orchard on May 18, two other orchards near it were also examined for winter-injury. One of them, consisting of rather scattered trees which had been set 6 to 10 years, was just south of the above orchard and consists of various varieties. On a knoll a 10-year-old tree had small patches of loose bark on the south and north sides of the crown at the surface of the ground. The loose patch on the north had a cleft about 7 cm. long and was alive except at the cleft edges. By cutting out the loose bark it was seen that regeneration had occurred on its inner side near the cleft and that farther from the cleft were very numerous glistening points which corresponded with similar points on the wood surface. It appeared as though further growth might have turned out the edges of the bark at the cleft as it did on the maple trees discussed above and shown on Plates XX and XXIII. On the south side of the tree the cleft was only about 4 cm. long and the bark was lying rather firmly against the wood. It was not removed to determine the extent of loosening because it appeared as though it would be better for the tree to leave it. It seemed likely that in this case further growth would go on as it did on the one shown on Plate XII of the above cited paper on crown-rot.

The other orchard referred to above is about a half a mile farther south, set four years and in an exposed situation. The grower said that two years before a few of the trees had died in mid- and late-summer, and on examination were found to have wide girdles of

dead bark just above the ground. A number of the old wounds surrounded by rolls of callus were in evidence. A few of the trees were injured in the winter of 1910–11. In these instances, which were not very severe, the loose bark seemed to be dying out to the very limits of the injured areas.

Some Clyde orchards.— On the northwest edge of the village of Clyde are some apple orchards that were also injured in the winter of 1910–11. The most severely affected one consists of about 8 acres which had been set 4 years to Baldwin and Greening. The orchard lies east and west across the crest of a north and south hill. The east end of the orchard seems to be shielded from north and west winds by the crest of the hill and a house and trees respectively; but the middle and western portions are fully exposed to the wind. The soil is a light, clay loam, with a gravelly subsoil. It had been heaped about the trees over winter and removed in spring. The eastern part of the orchard has richer soil than the central and western part; and as a result the trees were appreciably larger in the eastern part.

On June 3, when the orchard was first visited, about 20 per ct. of the trees had moie or less dying bark on the stems. Perhaps three-fourths of the injured ones were Baldwin. There were as many injured trees in the east half as in the west half of the orchard, although the former was less exposed to the wind.

Many of the affected trees were completely girdled and a few of them could be distinguished at some distance by a slight yellowish tint of their foliage. Those with a bridge of living bark as wide as one-eighth of the circumference looked normal in every other respect. When the injured or loosened area of bark on a tree consisted of not more than half the circumference it was usually confined to the southwest side of the trunk.

The injured places began from 3 to 8 cm. above ground and extended up the stem from 7 to 18 cm.; but most commonly about 11 cm. The dead or dying bark was usually cleft in a number of places, and in cases of complete girdling much irregular callus growth had developed on the trunk over areas where the loose bark was not cleft. By turning to Plate IX the matter is more readily understood. Figure A shows a typical example in which much regeneration had occurred on the wood surface where it is covered by the old, dead bark; while at the cleft no growth had resulted. In comparing it with figure B, from which the loose bark had been removed, the regenerated part is even more prominent. There were two narrower clefts on the other or northeast side of the trunk. The figures also show that the removal of all dead and dying bark included some above and below the clefts which was not actually loose, but which was discolored to a dark brown in the phloem region. The wood underneath the discolored and partially live bark had also become

stained to the depth of several millimeters. Another and more striking illustration of this is shown in figures C and D which are also of a tree trunk before and after removing the dead and dying bark. In this case the bark was dying as much as several decimeters above the externally visible injury and the wood underneath was much discolored, apparently by the diffusion into it of some oxidizing agent coming from the disorganizing phloem. Figure E shows an instance where the cleft on the southwest side was uncommonly long; *i. e.*, where it had apparently extended to the *full length* of the bark injury. As may be noticed, the area over which regeneration from the wood resulted *is correspondingly long*. Although this tree had a much longer girdle of cleft, loose bark than those shown in figures A and C, more regeneration resulted and practically no additional bark was found discolored in the phloem, and no staining of the wood occurred with the exception of the superficial layers. And what is more interesting, the foliage of this and other similarly injured trees was of normal color, while those with much *stained* wood could be detected by the yellowish tint of their foliage.

Another thing noticeable from these figures is that some regeneration had occurred over practically the whole wood surface where the bark was completely separated but yet remained as a protecting cover, while above and below the places of complete separation the bark was usually more or less discolored in the phloem region and the underlying wood stained. That is, actual separation of the bark did not appear to be as harmful to the tree as a certain amount of injury in the phloem *when the bark was left on*. But in cases where the tree was *not completely* girdled the disorganization in the phloem of partially loosened bark, was not so marked; and the staining of the underlying wood less extensive.

The orchardist was advised to cut off all girdled trees, remove all loose or injured bark from the less injured ones, and cover the exposed wood with grafting wax or paint. Figures A and C on Plate X and figure A on Plate XI show some of the typical results as they appeared August 3, 1911. Figure B on Plate X is one of the sprouts grown on a Baldwin stump. Grafting wax had been used to cover the exposed wood. The wax seems to loosen from the margins of the wood and frequently crack open; no doubt some tar paint is better to cover *dead* wood surfaces, as may be seen from the results obtained in the above Weedsport orchard.

On a neighboring bleak clay hill is a very small mixed orchard of Ben Davis apples and peach trees, set 8 years. At the time of the first visit in June, 1911, a number of winter-injured Ben Davis trees were found in this orchard. There were perhaps 2 dozen apple trees in the orchard, very large and thrifty in appearance. The bases of the trunks had been incased in veneer protectors about 4.5 dm. high which were still on the trees. On removal of the protectors 5 of the trees were found to have areas of partially loose and decaying

bark on the northwest side beginning 5 to 8 cm. above the ground. But the injuries usually covered less than half of the circumference. In three of the cases unmistakable evidence of very narrow longitudinal clefts were found in the injured bark, but in the two others which were smaller, no indications of clefts could be seen. Figure A of Plate XI shows one of them after it had been covered with wax.

In view of the numerous other observations of this type of injury on trees without the veneer it seems highly probable that the protectors had no causal relation to the initial injury in this instance.

Two other Branchport orchards.— About 1.5 miles southwest of Branchport is a small 9-year-old apple orchard which consisted of 130 trees of Baldwin, Stark and Northern Spy. The land slopes toward the east and the soil is clay. On the south side is a small patch of forest while the west and northwest are open.

The trees had been thoroughly fertilized and cultivated; they had made a rapid growth. In the spring of 1910 while looking for "grubs" the grower found the bark of some trees injured at the ground, and in 1911 he found many with decayed bark at the crowns. On May 11, 1911, 8 of the trees had been taken out and perhaps 15 more were considerably crown-rotted. Their general appearance was like that of figure B on Plate XVIII.

Trees of all three varieties were affected but the injured ones were principally of the Baldwin variety.

Adjoining this orchard on the north was another with nearly twice as many trees, and of the same varieties, but apparently without a single tree injured. These trees were not as large as those in the neighboring orchard although they had also been set 9 years. The soil and slope of land were identical and the wind exposure seemed even greater. The trees were also headed about alike in both orchards. The only difference that could be found in the two was that the crown-rotted one had been thoroughly fertilized and cultivated while the other remained in sod.

A Middlesex orchard.— About a mile southwest of the village of Middlesex is a Baldwin apple orchard of 150 trees on high land, and with rather thin, gravelly soil. It is fully wind exposed in all directions.

The trees had been set three years and the orchard had been cultivated and cropped. The trees seemed rather small for that age. On June 2, six of the trees were found to have injured bark on the northwest side, near the ground. The most severely injured one had a patch of partially loose, cleft bark on its northwest side which extended more than half way round the trunk. Six injured trees had been replaced by the grower, in May, because they seemed to be dying.

A Milton orchard.— During the second week in June in a clean cultivated orchard about 2 miles west of Milton 3 Baldwin trees were found having small areas of loose, cleft bark at their crowns. About

half the loose bark was entirely dead and the remainder was evidently dying back to the *limits* of the loosened areas where a rim of callus had already begun to form.

The Hemlock orchards.— Near the eastern shore of Hemlock lake on a high, clay ridge is a small apple orchard which had been set 5 years. The orchard had been thoroughly cultivated and fertilized without being cropped, and the trees were large and thrifty looking for that age.

About 7 per ct. of them were injured at the surface of the ground. But only on four was the bark loosened in the phloem region, when the orchard was visited on June 5. A half dozen had large patches of periderm with some adhering cortical parenchyma cleft and loosened on the northwest side. The areas of bark loosened in the phloem region extended less than half way round the trunks, and only half the injured bark was dead. In spots where it was wholly separated from the wood considerable regeneration or callus formation, of the type shown on Plate IX, had occurred on the wood surface. On two of them there was some regeneration on the inner side of the loose bark somewhat like that shown on maples in Plate XX, but only in small patches. But on one of the trees most of the callused bark was evidently dying. It appeared as though the wound might become a ragged one in the course of a year or so more, like the old wound shown in figure A on Plate XIX. An irregular rusty looking surface had developed on the exposed patches on trees with the periderm loosened. The covering seemed to be made up of dead cortical tissues and newly formed cork.

In another small apple orchard on the same clay ridge and about a mile south of the one described above, there were 5 trees with yellowish foliage. They had apparently been set 8 years, and the orchard had been cultivated and cropped. The diseased trees were found to have crown-rot resulting from injuries which occurred during the winter of 1909–10. They were all completely girdled at the surface of the ground, and nearly all the dead bark had decayed, leaving a smooth surface of dead wood exposed much like that shown in figure B on Plate XVIII, except that the girdles were only about one-eighth as wide.

Some Glens Falls orchards.— In a wind-swept region a few miles north of Glens Falls are a number of small bearing apple orchards which were injured during the winter of 1910–11, but only two of them were actually studied. One orchard which consisted of perhaps two dozen trees of various ages and varieties adjoins farm buildings on the west and had 5 or 6 injured trees, chiefly 10 or more years old. The soil seemed productive and was under cultivation.

Two of the affected trees were crown-rotted in narrow bands extending about half way round the trunk at the surface of the ground. The initial injury on these seemed to have occurred during the winter of 1909-10. The other affected trees were injured in the winter of

1910–11, and their general appearence was normal. But the bark was cleft and loosened on the north side as may be seen from figures A and B on Plate XIV. The clefts did not extend the entire length of the loosened area; for example, in the case shown in figure A the bark was loosened or nearly so from a few centimeters above ground up about twice the length of the cleft and nearly half way round the trunk. About two-thirds of the loosened bark was still alive but in a wilted condition. The portions around the clefts were dead and dry. No definite regeneration had occurred between the bark and the wood but considerable disorganized brown slime was present under it.

Figure B shows a case where the bark was loosened higher up on the trunk and where less than the circumference was involved. In this instance the loosened bark was nearly all alive and the wood, except that immediately under the cleft, was discolored but little and seemed to be regenerating and apparently establishing new connections with the live bark in many places. No indications of corky layers were noticed between the bark and wood, as was the case in maples shown on Plates XX and XXIII. Otherwise these cases were very similar to those so frequently found on maples. The nature of the injury and the type of regeneration seen in figure B of Plate XIV seemed more like that shown on Plate XII of the above cited paper on crown-rot, and like that shown in figure B of Plate XXII of the present paper.

The other orchard studied is about 100 meters northeast of the first one; it is in sod and seemed to have a more sheltered location. The trees were mainly from 9 to 10 years old. The grower said that they had been pruned very lightly until June, 1910, and January, 1911, when they were severely pruned. The soil was very compact but apparently productive, for the grass and trees looked thrifty. The trees were strongly rooted and stood firm.

The orchard consisted of 89 trees of Baldwin, Northern Spy and other varieties. Thirteen trees were completely girdled and 28 others were less severely injured. The bark was cleft more or less on all affected ones, but usually only a fraction of the length of the loosened areas. Most of it was also partly alive, at least the part somewhat removed from the clefts. The height of the girdles of loosened bark varied much on different trees and sometimes they were much higher on one side than on the other, as shown in figure A on Plate XV. Those trees having only a slight injury most commonly had that on the northwest side near the ground. But it was usually impossible to say which side was most affected in case a tree was completely girdled, unless the girdle was high on one side. Figures A and B on Plate XV are typical examples of complete girdling.

Figure A is an instance in which the greatest injury had occurred on the northwest side, extending from the ground up to the branches; while on the opposite side it extended only a few decimeters above the ground. There was a cleft in the bark on the northwest extending

about half or two-thirds of the way up to the branches, and a few very short clefts or perhaps wind-checks were scattered over the base of the south side. About three-fourths of the loosened bark was partly alive, and in some spots more or less regeneration had occurred on the wood surface under it. At the right of figure A on Plate XV some such spots are readily seen as darkened areas. Most of the bark on the northwest side, including the piece hanging by its upper end, was dead and the wood surface underneath had a dark brown color. The loose bark taken from B had been cleft at a few places near the ground, but none of the clefts reached more than a fourth of the way up the trunk. All of the bark except that surrounding the clefts still appeared normal externally but on removal was found to have a rusty or dark brown color on its inner side. Between the closely appressed bark and the wood was some disorganized and discolored slime. The loose bark was not uniform throughout; there were often large areas in which it was dead and discolored only to the outer layers of cortex, while in others even the whole of the cortex had died in small spots. It seemed evident that the entire loosened portion of bark was dying from within outward.

For trees of that age this is an unusually high percentage of injured ones. Over 46 per ct. of them were more or less severely affected and over 15 per ct. were completely girdled or fatally injured. Yet, when the orchard was first seen the foliage of all trees appeared of the same normal color, although after the loosened bark had been removed one could readily imagine that the leaves of most of the girdled trees were of a yellowish or lighter shade of green than the others. That seemed most noticeable on trees like that in figure B on Plate XV, which had much discoloration of the wood.

Several of the less severely affected trees also had injured bark in their lower crotches. In some cases the injured bark looked discolored or dead while in others it still appeared normal externally although on removal was found to be partially separated from the wood and to have a rusty to brown dark phloem. In other instances small clefts or wind-checks were present in the dead bark, but most frequently it was uncleft. When patches of injured bark had completely died they looked like typical crotch cankers. The dead areas were sunken below the level of the normal bark and were unusually delimited by a more or less conspicuous line of fissure. In cases where the cortical portion of the affected bark was yet mostly alive the fissure was less conspicuous or even entirely absent, but on cutting out a piece across the indefinite region of transition from the injured to the normal bark the cause and location of the cleavage became apparent. A definite but thin ridge of callus was found running around the periphery of the injured areas, indicating that the cause of the fissure is the increase in thickness under the normal bark and its absence of thickening, combined with the drying out and dying of the bark, over the several affected areas.

Sphæropsis and Cytospora were found sporulating on much of the loosened bark which had died, and occasionally Sphæropsis was also present on bark that was loosened but not dead throughout. In a few instances Sphæropsis was fruiting on dead patches of bark about injured crotches. It appeared very probable, however, that the fungi were only saprophytes in these cases because the bark was not found injured beyond the first callus that had formed in early summer under the loosened bark around the periphery of the initially injured regions.

The Interlaken orchards.— Along the western edge of Interlaken is a small apple orchard which had been set two years. The land has a gentle slope toward the north and is fully wind exposed on the north, west, and southwest. It had been thoroughly cultivated.

There were 60 trees of each of the following varieties: Hubbardston, McIntosh, Rome and Wealthy. When the orchard was visited on August 5 the leaves on all but three trees had a normal color. On these the foliage had a yellowish tint. The lower portion of the stem of one of them is shown in figure C on Plate XVI. The three trees with yellowish leaves were completely girdled as shown in this figure, and apparently the injured region of bark was not wholly separated from the wood for it was still adhering in many places although it was much dried and wind-checked. A very thick roll of callus had formed along the upper edge of the girdle but no regeneration occurred on the wood of the injured region. The wood was much discolored to the depth of over a centimeter. A fairly vigorous sprout had developed from the stump of every girdled tree.

Most of the other affected trees had injured areas often extending as far as half way round the trunks, as shown in figure A of the above plate, which was taken after removing the dry bark that was still partially adhering to the dead wood underneath. None of the affected trees showed regeneration except along the edges of live bark as shown in A.

The Hubbardston trees were apparently more susceptible than the other varieties. The three discussed above were of that variety, and 20 others were less severely injured. Only 2 per ct. of each of the other varieties were affected.

About 2 miles farther northwest and not far from Lodi is an orchard of about 17 acres which had also been set 2 years. The soil was richer and the trees were larger than in the above orchard. It had also been cultivated and cropped. On the south side is a dense old apple orchard but otherwise the exposure was almost the same as that of the one discussed above.

It consisted of 200 trees each of Baldwin, McIntosh and Wealthy; 175 Greenings, 100 Hubbardstons, and a few trees of some other varieties. About 40 Hubbardston trees were injured on the northeast side, but in most cases the affected areas covered less than half the circumference of the stems just above the ground. On a few

of them there was a narrowing upward extension of the injury as shown in figure B on Plate XVI. In this instance the grower had previously sent a man to clean out the wounds and paint them, but as may be seen from this figure the injured bark had not all been removed before paint was applied; at the upper and lower ends the paint had been applied to the affected bark instead. The photograph was taken after the additional dead bark was removed, thus showing the result of careless work.

A few McIntosh, two Northern Spy and about 15 Baldwin trees were also slightly injured. One Wealthy tree was completely girdled and looked like the Hubbardston shown in figure C referred to above.

The counts in this orchard seem also to indicate that the Hubbardston is more susceptible than the Baldwin. Forty Hubbardstons out of 100 were injured while only 15 out of 200 Baldwins were affected.

A Le Roy orchard.— A few miles from Le Roy is an apple orchard which had been set 9 years, consisting of over 400 trees of several varieties. It is a sod orchard but the trees had been growing at a good rate.

In the fall of 1906 the basal ends of the tree trunks had been incased in veneer protectors about 51 cm. high, and they were not removed until the spring of 1910. In 1908, 1909, 1910, and 1911 the grower found some of the trunks with newly diseased areas of bark, chiefly on the southwest side, from which discolored "sap" flowed in the spring and again the following July of the same season. The new cases of injury became evident in large numbers in the spring of 1910, when the protectors were removed, and again in 1911.

About 60 trees were found injured in 1910 and perhaps a similar number in 1911, for the grower said that from June 24 to 26 he had found the injury on 50 trees and by the last of July some additional ones were noticed with discolored "sap" flowing from variously discolored spots and areas of bark on the south and southwest sides.

When the orchard was visited by the writer on August 7 the general appearance of the newer, bleeding injuries as well as those which had become circumscribed by rolls of healthy callus of from one to three years' growth, was much like that of injuries studied in one of the Barnes orchards and somewhat like that in the Coldwater orchard.

Small and irregular scattered groups of cortical cells and occasionally patches of underlying phloem had evidently been injured, and in many cases the injured spots and patches had become confluent by the dying of the interspersed groups of live tissues; thus resulting in irregular dead areas in the bark which in some cases, where the underlying phloem had been injured, extended to the wood. Figure B on Plate XVII shows an example on which most of the injured and dead bark has been removed with a sharp knife. In this case

some live spots were encountered on reaching the phloem and after cutting away the bark about 1 mm. deeper, irregular areas of live and dead tissues were found intermingled on the cut surface, giving it a marbled appearance. The injured spots were variously discolored from pink to blue, brown and black. A dark colored "sap" had been exuding from some very short and narrow clefts in the outer bark of this area. Some of the clefts reached even deeper than the bark had been cut away, for several of them may be seen as small ragged rifts in the cut surface.

The location of these injured patches, on the southwest side of trunks, varied considerably. They were situated anywhere from a few centimeters above the ground up to the first crotches. But the location of the maximum injury corresponded to the height to which normal bark roughening or scaling had attained on the trunk. It may also be seen in the above figure that the bark surface below and including the area of greatest injury is roughened or has begun to scale off as the bark of trees does when a certain stage in its life history is reached. Above the injured area are a few superficial checks here and there, as is commonly the case in the region of transition from rough to smooth bark. In the instance shown in figure A of Plate XVII maximal injury resulted below the main crotches, about 85 cm. above ground. Here the greatest injury also occurred in the region of transition from rough to smooth bark, with a few lesser spots of exposed wood in evidence lower down. This is one of the trees found exuding discolored "sap" from injured bark covering these exposed areas in 1909. At the right and left of the stem may be seen some successful bridge grafts extending from near the ground to the branches. The tree bore a normal crop in 1911 and will probably live many years, although its lease on life has doubtless been foreshortened by leaving the exposed wood unpainted, for after the central cylinder of wood has rotted a strong summer wind will probably break it off.

It seems unlikely that the veneer around the bases of these trees had any causal relation to the bark injury, as was suggested by Stewart.[1] First, becase affected areas were mainly on one side of the trunks and were frequently above the veneer. Second, because similar new cases of injury were found in 1911 as had been observed in 1910, and affected areas seemed always to be on a region of bark that was in a certain stage of its development whether that be *under* or *above* the veneer.

It seems that the two periods of exudation of "sap" from such injured patches of bark occur during the two periods of high sap pressure, in spring and in July. Doubtless the dying, in early summer, of groups of live cells which are scattered among winter-injured

[1] F. C. Stewart Notes on New York plant diseases, I. N. Y. Agrl. Expt. Sta. Bul. 328:323–24. 1910.

spots in the bark also contributes to the July period of exudation of discolored "sap." It appears as though the high pressure forces it out through the broken or dead tissues.

Another Sodus orchard.— In a 5-acre apple orchard near Sodus about 5 per ct. of the trees were found affected at the crown or crotches or both, when visited on August 9. The ground is almost level and exposed to the wind, and the soil is a clay loam which seems fairly productive. It is cultivated and cropped. The trees had been set two years and had made a good growth. They are of the varieties Wolf River and Wealthy.

The injury at the crowns had evidently been of the usual type, but the injured and partially loose bark had all died. In most cases but little regeneration occurred, although on a few trees the appearance of unevenness due to regeneration was much like that in the Clyde orchard described above. Only about half a dozen of them were completely girdled at the crown and looked like that in figure C on Plate XVI from an Interlaken orchard. Other affected trees were chiefly less than half girdled and had normal colored leaves.

But the most interesting phase of the injury on the trees of this orchard was confined to the crotches of the main branches. Various sized areas of dead bark were present in and around some crotches of perhaps 15 per ct. of the trees. In some instances the outer bark still appeared normal externally but when cut open the phloem region was found of a rusty brown color and disorganized into a slimy mass. In other cases the outer bark had just died and the whole affected area had a dark brown color and contained dark "sap." Many of the injured patches of bark had died and become dry and sunken below the general bark surface. On two trees Sphæropsis pycnidia had appeared on the dead bark.

On quite a number of the crotch-injured trees one or more of the most severely affected branches had died or were dying. The wood underneath the bark of such crotch-girdled branches was much stained; in fact in most cases where such a crotch-injured branch had died or had yellow foliage, the entire wood cylinder under the affected bark had become stained. The injury at the crowns was mainly on the west side, but that in and around crotches was localized with reference to the manner of branching.

In a neighboring 3- to 4-year-old sour cherry orchard one of the largest trees seemed to have the "yellows." Its foliage was said to have had a normal color a month previous, but now it looked bright yellow with here and there a tint of pink. On closer examination a slight enlargement was found on the stem about 7 cm. above the ground; although the bark below the swelling appeared normal it proved to be dead down to the ground, and the enlargement was a callus growth along the upper edge of a dead girdle of bark, very similar to the growths resulting on girdled young apple trees. The

space between the bark and the wood, along the lower edge of the callus, was filled with gum and the wood under the lower half of the girdle was stained to the depth of perhaps a centimeter. The roots of the tree appeared normal.

A Geneva peach orchard.— In a young and bearing peach orchard on the Experiment Station farm about 3 per ct. of the trees were found to have patches of injured bark on their trunks just above the ground. Three of the trees were completely girdled and more or less enlarged above the wound, like the sour cherry tree discussed above. But on most of the affected trees the dead areas of bark reached less than half way round the trunks, and the trees continued to look normal in 1911 and 1912. However, the foliage on the completely girdled ones had a yellowish tint in July and then some of it became pinkish here and there. Figure A on Plate XVIII is an example on which the enlargement was not very marked but where the dead region was conspicuous on account of its being smaller than the trunk above. Along the upper edge of the girdle the bark stood out from the wood and the resulting cavity was filled with gum on July 5. On other portions of the affected area the bark seemed only partially loosened by the disorganization of the phloem, and no radial clefts were present. The wood covered by the dead bark had become stained to a depth of about 5 mm.

The so-called bark-beetles (Scolytus) were boring into the bark of the completely girdled trees. On the trunk, larger branches and especially about the bases of small twigs the tiny cylindrical holes of that insect were present in large numbers, but no borer holes were seen on the normal nor on the slightly affected trees.

During early July the stumps of several young peach trees which had been similarly affected by winter-injury and borers, were received at the Experiment Station from different parts of western New York. In most of these cases a rather conspicuous enlargement or swelling occurred just above the dead girdle. No radial clefts were found in the dead bark and the gum was present under the raised portion of bark just below the callus. The phloem of the dead bark had been disorganized as in the Geneva cases and on the Sodus cherry tree, but the roots in all cases were normal as yet. The cases of injury involving less than a complete girdle always occurred on the northwest side of trunks in the Geneva orchard. There is not very much wind protection, and the trees had been growing uncommonly fast.

During late August Cytospora pycnidia, apparently the imperfect stage of *Valsa leucostoma*, were present in great numbers on the dead bark that had been left on affected trees. But no example was seen where the fungus had killed bark beyond the periphery of the original injury, as bounded by callus along the margin of areas severely affected very early in the vegetative season.

Initial injuries resulting in crown-rot produced experimentally.— Some apple trees in a seedling orchard consisting of various crosses between different varieties had been discarded, on account of undesirable qualities of their fruit. These trees were kindly given by the Horticulturist of this Station for experimental tests. The ones used for this preliminary experiment were crosses of the following varieties: Two of them were Ben Davis X Mother, germinated in 1900; one Esopus X Ben Davis, and another Ben Davis X McIntosh, which were germinated in 1899. They were set about 3 m. apart and were about the size of trees set 6 or 7 years. They bore full crops of fruit when used in the experiment on September 14, 1911.

The stem of each of the four trees used was encased in oilcloth the overlapping edge of which was sealed down with shellac. Then a sleeve from 70 to 85 cm. long was put around each trunk by rolling together a piece of galvanized iron and tying it with wire in such a way as to leave a space of about 8 cm. between it and the oilcloth surrounding the stem. Sawdust to the depth of about 5 cm. was tamped in the bottom of the galvanized iron cylinders around the bases of the trunks. About equal parts of finely crushed ice and calcium chloride were then added in alternating thin layers to the depth of 30 to 40 cm. The space above the freezing mixture was also filled with sawdust. By the time the last sawdust had been added hoarfrost had formed on the outside of the galvanized iron in the region of the freezing mixture.

Ice was piled in the form of a cone around trees 2/9 (Ben Davis X Mother) and 5/6 (Esopus X Ben Davis) up to the top of the freezing apparatus and covered with sawdust. Four long radial slits had been made in the bark of the trunks of numbers 2/9 and 5/6 before they were covered with oilcloth.

A thermometer for measuring low temperatures not being available no record of the resulting temperatures was obtained, but it seems conservative to estimate it at about — 25° C., thus allowing a loss of nearly 20° C. by conduction.

On September 16, two days after the freezing experiment was performed, about a fourth of the foliage on the treated trees was dry although still green, and much of the other drooped or curled more or less. Many of the slender bearing twigs appeared to droop more than those of neighboring untreated trees; all of which indicates that water conduction had been interfered with by the freezing of the trunks. The ice and salt in the galvanized iron cylinders had all melted, but a few lumps of ice were still present in the sawdust outside of two of them.

The effect of the low temperatures on the bark of the enclosed portion of the stems varied considerably, but it had been injurious on all of them. On tree 1/25 (Ben Davis X Mother) which measured 31.9 cm. in circumference, the bark on the northwest side had a few

scattered brown blotches from about 3 cm. above ground up nearly 12 cm., but no clefts had resulted. On removal much of the phloem in that region, about half way round the stem, had a brown color, although there were groups of normal colored phloem tissues scattered along in the affected area. Most of the cortex, aside from the blotches referred to above, was of normal color and apparently uninjured. The whole discolored area of bark was removed and the wood underneath it was found to have a normal color also.

Tree 2/9 (Ben Davis X Mother) having a circumference of 36 cm. and on which the bark had been slit, sustained injuries of a different type, but they were also confined to the lower portion of the trunk. The evident injuries were on the north side and did not extend more than 16 cm. above ground, but there were no clefts aside from the slits made before. A strip of bark on the north side between two of the slits which were about a fourth of the circumference of the trunk apart was loosened from 6 cm. above ground up 7 or 8 cm. It was of normal color except on its inner side where it was slightly browned. The wood surface underneath had a similar appearance. The bark on the west side was also removed but no discolored spots were found in it; however, the edges of the bark along the slits were loose.

On tree 3/12 (Ben Davis X McIntosh) which had a circumference of 34.3 cm. the bark appeared discolored on the southwest side over an area of about a third of the circumference and from 5 cm. above ground up 7 or 8 cm. In this case there were only a few small groups of cortical cells in the whole discolored area that were of normal color. Practically the entire phloem was also discolored but the wood underneath appeared normal. The tree was cut off and no discoloration was evident in the wood. However, a few spots were found in the phloem and inner cortex. The injury was confined to the basal 15 cm. of the trunk.

Tree 5/6 (Esopus X Ben Davis) measured 30.5 cm. in circumference. The bark was loosened very slightly on the west side along one slit and it had a discolored area on the northwest side covering about a third of the circumference. This discolored patch was similar to that described on tree 1/25, except that there were fewer and smaller normal colored spots in its interior. The discolored and loose bark was removed and the wood underneath appeared normal. The injury was all within 15 cm. of the ground.

September 18, four days after treatment, hundreds of the bark-beetles (Scolytus) were present on the remaining three trees, although none could be seen on the surrounding untreated ones. They were especially numerous on trees 1/25 and 2/9 where large numbers of small round holes had been dug or were being dug into the bark of stems, main branches, and around the bases of small twigs and spurs. It seemed as though each hole was bored by a pair of the beetles; at any rate, in instances where a beetle was actually boring

there was always one waiting at the rim of the hole. Tree 5/6 was infested with fewer beetles, and since the injured trees were about the same distances apart and similarly surrounded by normal ones, it appeared to indicate a difference in the trees which had been treated. As a matter of fact there was a slight difference in the amount of dead foliage on the treated trees: tree 5/6 had least and tree 2/9 had most of it. But nearly a third of the foliage of the latter tree was still living and appeared more turgid than it did two days before.

Since the bark on the treated trees was all alive and of normal color (except some on the trunks near the ground) it is difficult to understand how these beetles selected only the injured trees on which to bore, unless it be by differences in turgidity or water content of the bark though the presence of clumps of dead leaves may have been a sign for attack.

In this connection it may be of interest to note that D. H. Jones has recently published an article[1] on *Scolytus rugulosus* as an agent in the spread of bacterial blight of pear trees.

OBSERVATIONS DURING 1912.

The field observations during 1912 were mainly of a supplementary nature. Observations had shown that the types of winter-injury under consideration, which may result in crown-rot and cankers, occurred sometime between the middle of November, 1910, and the first part of January, 1911; also that after thawing and during the following vegetative activities injured tissues become discolored and more or less disorganized, leading to discoloration and death of some adjoining and of all isolated live tissues. During the winter of 1911-12 and the following summer, an effort was made to localize more definitely the time of occurrence of these injuries in winter; to study the histological modifications induced, and to make further observations on trees injured in winter of 1910-11.

During last scholastic year observations were made in and around Madison, Wisconsin, and after the first of June were continued in New York. The histological study begun in the University of Wisconsin had to be discontinued after arriving at the Experiment Station on account of lack of necessary apparatus; but the field observations and the fixing of material for the histological study were continued. Since the material yet remaining necessary for a histological study of the initial injuries and the subsequent changes taking place in affected areas had been fixed and infiltrated with celloidin, the gaps in the studies made in the University of Wisconsin

[1] D. H. Jones. Scolytus rugulosus as an agent in the spread of bacterial blight on pear trees.
Phytopath. 1:155-58. 1911.

and the further extension of the histological series into the early summer may be finished at odd times so that its publication should not be long delayed.

Late fall and early winter were rather rough and cold around Madison. The average temperature for both October and November was below the normal. But December was an uncommonly mild month with the temperature ranging considerably above the normal, except during the last few days when it sank to — 22.2° C. January was colder than any previous January on the records of the United States Weather Bureau for that region; the temperature was over 8° C. below the normal. The highest temperature was — 0.55° C. and the lowest — 31.6° C. The temperature in February was also 2.7° C. below the normal. The highest temperature during the month was — 7.7° C. and the lowest — 27.3° C. The March record was 3.8° C. below normal, with a minimum of less than — 20° C. Many periods of high winds occurred; one of the strongest lasted most of the day on December 10 with a maximum during the middle of the afternoon of 56 miles per hour, and exerting a force of nearly 17 pounds per square foot.

In western New York the weather was very similar to that described for the Madison region except that it was not quite so cold.

At Madison three small apple orchards on the university farm were easily accessible for observation and study. One had been set about two and another about six years; while the third orchard consisted chiefly of trees that had been set some 9 to 14 years. In the oldest orchard many trees of undesirable varieties were kindly put at the writer's disposal by J. G. Moore, Professor of Horticulture in the University. The trees in these orchards were examined several times during the winter in order to determine if possible the time of injury.

Only three cases of crown-rot were found, and those were on trees in the oldest orchard. The initial bark injury seemed to have occurred during the winter of 1909–10, as judged by the presence of callus of two years' growth around the wounds. In no instance, however, did the injury extend more than half way around the base of the trunk.

Effect of changes in temperature on the circumference of tree trunks.— In order to secure some first-hand data on the effect of low temperature on the circumference of tree trunks a small number of apple trees in the oldest orchards were measured at different times. The regions around which the measurements were taken were marked at two points on each tree in order that the different measurements would be more comparable. They were made with a steel tape-measure which when used during low temperature naturally somewhat minimized the results of the contraction of the tree trunks.

The following table shows the changes in circumference induced by changes in temperature:

TABLE I.—CHANGES IN CIRCUMFERENCE OF APPLE TREE TRUNKS DURING WINTER.

DESIGNATION OF TREES	Circumference Nov. 8, 1911 temperature 6.6° C.	Circumference Nov. 13, 1911 temperature — 9.4° C.	Circumference Jan. 6, 1912 temperature — 28.3° C.	Circumference April 6, 1912 temperature 21° C.	Maximum shrinkage of circumference
	Cm.	*Cm.*	*Cm.*	*Cm.*	*Per ct.*
3/15.........	71.3	71.0	69.6	71.0	2.3
5/23.........	64.9	64.6	63.5	64.6	2.1
7/28.........	43.8	43.5	42.4	43.6	3.1
7/21.........	48.6	48.3	47.6	48.5	2.0
9/25.........	59.5	59.1	58.4	59.5	1.8
9/23.........	51.1	50.8	50.1	51.0	1.9
9/22.........	51.8	51.5	50.8	51.7	1.9
11/21........	67.6	67.1	66.4	67.6	1.7

As may be seen in the last vertical column of this table the percentages of decrease in the circumferences of the 8 tree trunks varies from 1.8 to 3.1, and the average is a little over 2 per ct. It is also interesting to note that the contraction resulting from a change of temperature from 6.6° C. to — 9.4° C. is not as great per degree of change in temperature as it is in the range from — 9.4° C. to — 28.3° C. In the first case a change of 16° C. resulted in an average contraction of only a little over 3 mm. or 0.19 mm. per degree of change; while in the second an additional change of 18.9° C. caused a contraction averaging 8.8 mm. or 0.46 mm. per degree of change. The measurements taken on April 6, although made at a higher temperature than those of November 8, averaged less; and none of them were above the first November measurements. Possibly that is an error of observation, yet it may indicate a slight diminution in size due to a loss of water during winter.

Tree trunks cleft open during the first excessive cold period.— The excessive cold period in the winter of 1911–12 came during the first week of January with a minimum temperature of — 31.1° C. On January 6 quite a number of tree trunks in the above apple orchard were cleft open a little above the ground and others in the lowest crotches. The clefts in the trunks were from 2 to 5 dm. long and from 5 to 15 mm. wide. They extended at least to the pith as shown by the insertion of a sharpened stick. The clefts were mostly on the north and west sides. The crotch clefts were always at right angles to the branching and usually widest above, appearing as though the crotches had been split by driving in a thin wedge from

above. In two instances where measurements were taken the component parts of the crotches had separated about 2 cm., which seems to indicate that there had also been a longitudinal contraction of the outer portions of the trunks, thus resulting in an outward bending of the branches. The bark, however, had not separated or loosened from the wood along the clefts.

Many shade trees in the city of Madison, including maple, oak, catalpa, linden, etc., also had their trunks cleft open during the first week of January. Frequently a long cleft extended from near the ground up as high as 2 meters, and one or more shorter ones from near the ground up about 5 dm. or less. The longer clefts went at least as far in as the center of the trunk. No bark had been loosened.

Changes in circumference of cleft trunks due to rise of temperature.—Some measurements were taken on linden and catalpa trees on January 6 when the thermometer stood at —28.3° C., which are recorded in the table below. In this case, also, errors that may have arisen due to the contraction of the steel tape-measure would result in giving higher values to the measurements at low temperatures and thus give slightly lower percentages of increase in the circumference when compared with those taken at higher temperatures. The measurements were made at marked points on the trunks and also included the width of the clefts. When the second measurement was made the clefts had all closed tightly. The change in circumference that

TABLE II.—MEASUREMENTS ON SHADE TREES IN MADISON WHICH WERE CLEFT DURING THE WINTER OF 1911–12

DESIGNATION OF TREES	Circumference Jan. 6, 1912, temperature — 28.3° C.	Location, width and length of clefts.			Circumference April 6, 1912, temperature 21° C.	Increase in circumference	
	Cm.		*Cm.*	*M.*	*Cm.*	*Per ct.*	*Per ct.*
1. Linden...	197.5	South side..	2.0	2.4	202.0	2.2	3.3
2. Linden...	186.7	West side..	1.6	2.5	189.6	1.5	2.4
3. Linden...	199.2	Southwest..	2.0	2.4	202.8	1.8	2.8
4. Linden...	159.0	Southwest..	2.2	4.0	161.9	1.8	3.2
5. Catalpa..	67.3	Southeast...	1.8	0.7	68.6	1.9	3.2
6. Catalpa..	42.8	Northwest..	1.3	0.7	43.8	2.3	5.5
7. Catalpa..	40.0	West side...	1.3	1.0	40.9	2.2	5.6

these tree trunks underwent between January 6 and April 6 was therefore greater than is shown by the measurements on which the first column of percentages is based. After deducing the width of the clefts from the measurements made on January 6, the percentages of increase in the circumferences are appreciably higher, as shown in the last vertical column.

An experiment in rapid thawing and swaying of apple trees.— On January 8 about 5 liters of water with a temperature of nearly 60° C. was poured in splashes on the lowest crotches of each of two apple trees in the oldest orchard, and allowed to run down the trunks. Immediately after application of water the trees were swayed vigorously during about a minute. It was in the afternoon and the temperature had risen to about — 26° C. The trees were of normal appearance. One of them had been set about 9 and the other about 12 years. Perhaps a liter of water was left after the second tree had been treated and was let stand in a tin vessel in the snow while the tree was being swayed. The remaining water was then splashed on to the lowest crotch of another large apple tree and ran down its trunk. On another tree two branches about 2.5 cm. in diameter were bent downward, considerably, a number of times, but not far enough to cause any audible breaking.

By testing with a knife it was found that the bark and a little of the outer wood had been thawed by the hot water, but a few minutes after the application of water had been made the whole wet surface was coated with a thin sheet of ice. One of the swayed trees was sawed off about 20 cm. above ground and carefully examined for indications of discoloration or injury, but none could be found in any part of its trunk.

About the middle of March, after all aerial portions of trees had been thawed for several days, practically the entire bark of the remaining tree-trunk receiving the hot water treatment in January had died and become brown. There were only a few small blotches of green colored outer cortex here and there that seemed to be alive. The whole phloem as well as the outer surface of the wood had become discolored over all parts of the tree where the hot water had been applied. On the inner side of the branches as much as 2 dm. above the crotches the bark had all died and become brown. All the bark on the stump of the tree that had been sawed off was also dead and brown to the ground. On the side on which most water had been splashed the bark was dead below the surface of the ground and around the bases of some roots.

The bark had not become loosened on the trees given the hot water treatment but considerable disorganization had occurred in the phloem region. Above ground the injured bark seemed to have dried out a little, but underground and at its surface the affected bark was full of brown "sap." About a fourth of the bark of the tree on which the last water had been poured was also found dead. The greatest effect occurred in the crotch and over an irregular area extending down the trunk about 3 to 4 dm. on the side receiving the hot water.

The bark on both of the branches which had been bent downward was partially loose on the upper side, and dead over a length of about

2 dm. where the bending had occurred. The general appearance was that of so-called "sun-scald." The affected bark was rusty brown in color and the phloem region was much disorganized.

Effect of low temperature on the diameter of apples and potatoes.—On January 8 some medium-sized potato tubers and apples were carefully measured with a caliper by adjusting it against the heads of two pins which had been stuck into the specimens at opposite points of the greatest diameter, up to the heads. Afterwards they were placed out of doors and left there over night with the temperature ranging around — 27° C. Early the next morning one was taken in at a time and remeasured over the pin-heads. The data are recorded in the following table:

TABLE III.—CHANGES IN DIAMETER OF APPLE FRUIT AND POTATO TUBERS INDUCED BY LOW TEMPERATURE

Apple No. 1,	diameter	in evening	77.5 mm.,	in morning		77.4 mm.
Apple No. 2,	"	" "	77.3 mm.,	"	"	77.0 mm.
Apple No. 3,	"	" "	78.0 mm.,	"	"	77.9 mm.
Tuber No. 1,	"	" "	96.5 mm.,	"	"	97.0 mm.
Tuber No. 2,	"	" "	98.7 mm.,	"	"	100.2 mm.
Tuber No. 3,	"	" "	88.0 mm.,	"	"	89.5 mm.
Tuber No. 4,	"	" "	114.0 mm.,	"	"	116.5 mm.

This shows an average decrease in the greatest diameter of the apples of 0.16 mm. or about 0.2 per ct.; and an average increase in the longest diameter of the potato tubers of 1.75 mm. or about 1.7 per ct.

Discoloration, after thawing, of structures injured by low temperatures.—Winter- or low-temperature injured plant structures can usually not be recognized as being injuriously affected until after they have thawed and become discolored. However, in some instances injuries may be seen by microscopic examination immediately after thawing or even while frozen. Some of the potatoes and apples used in the above experiment were placed outside an east window and the others were thawed and cut in pieces for microscopic examination and for observing the development of discoloration in air, water, etc.

The thawed tubers were very soft but of normal color. The "sap" could be squeezed out with the hand as readily as water from a sponge. By using thin hand sections it was easily seen that many of the cells had been broken and others separated along the middle lamellæ. The thawed apples were soft also but not spongy like the tubers. Fewer cells were broken and separated, in fact at the calyx end there was practically no indication of injury.

Pieces of tubers were placed into 15, 30, 50, 70, 80, 95 per ct., and absolute alcohol; in distilled water, and into 2 per ct. formalin. Pieces of both apple and potato were exposed to the air over night.

On the following day the pieces of potato exposed to air had become

very dark brown on the outside, and the pieces of apple had a rusty brown color throughout except around the calyx end, where there was still some normal colored tissue. The pieces of potato in water were almost as much discolored as those in air; and those in the lower alcohols seemed to have a very faint muddy-yellow discoloration. About a week later the pieces in the alcohols from 15 to 70 per ct. had all changed to a light brown or black color, while those in 80 per ct. were but slightly discolored. The pieces in 95 per ct. and absolute alcohol, and in 2 per ct. formalin had remained unchanged.

Crotch and other bark injuries observed in Madison orchards.— In the three University orchards described above much bark injury occurred during the winter of 1911–12, and presumably during the excessive cold weather in January, because no injury could be found in the latter part of November or before the steady cold weather began. The fact that both bark and wood clefts occurred in the first week in January makes it appear plausible that the bark injuries in crotches and other parts of trees occurred at least not later than that date; and, as will appear in another connection, it seems likely that this injury also occurred at this time. At any rate, when the orchards were examined again late in March and early April many trees were found having very severe injuries in the inner bark of crotches and callus growths around old wounds.

About a fourth of the trees in the apple orchard which had been set about two years had the inner bark of several crotches more or less severely injured, although no indication of injury could be seen outside. The cortical tissues were nearly all green and normal looking while much of the phloem was discolored and often had a region near the cambial zone where a disorganization or partial separation had occurred in such a way as to partially or even completely loosen the bark in various sized areas or patches.

No difference in general appearance could be detected between injured and sound trees, nor could the injured crotches be told from those not affected. The injury was chiefly confined to the main crotches and the bases of one- and two-year-old, ascending shoots coming from the lower parts of larger branches. The affected areas in the larger crotches involved the angle of the crotch and the inner side of both component branches up to various heights, depending upon the size of the affected region.

In the most severe cases the affected area usually involved from 2 to 3 cm. of bark on the inside of the branches of a crotch as well as that surrounding its angle to as much as 4 cm. below.

The injury around the bases of ascending shoots originating from dormant or adventitious buds on the larger branches was much like that in the crotches and was always most severe and sometimes even confined to the bark in the lesser angle between the shoot and branch from which it grew. In many instances, however, the inner bark or

phloem region was affected all around the base of shoots, and to such a degree as to be almost entirely loosened in a girdle one or more centimeters in width. The affected region in the phloem had a rusty brown color just like that in injured areas of the larger crotches. But there were no radial clefts in any of the affected regions.

Probably more than half of the trees in the other young apple orchard which had been set about 6 or 7 years were crotch-injured. In this case, however, the affected areas in the larger crotches often involved the bark on the inner side of the branches and below the angle to the extent of 8 to 10 cm. The injuries around the bases of young ascending shoots on these trees were also more extensive and severe than in the above younger orchard.

There were probably a half dozen of the large trees in the oldest apple orchard (set 8 to 14 years) found injured in the crotches, but only on two of them had the injury been severe. In these cases areas of bark as large as a man's hand were sufficiently affected in the phloem region to be partially loosened. In another instance the bark on a normal looking callus surrounding an old crown-rot scar was also much discolored in the inner phloem and looked as though it had been sufficiently isolated by the affected tissues to result in the death of the entire outer bark over the injured area, thus probably giving rise to a canker-like region of successive stages of development as is shown on maples in figures B of Plates XXIV and XXV, and to a less degree in figure A of Plate XIX. A similar injury was also found on callus growths of large sour cherry trees on the north side of this apple orchard.

In none of the cases of this type of bark injury in any of the orchards could a trace of radial clefts be found. The loosening of the bark seemed to have been brought about by injury or partial rupture in the inner phloem thus isolating the bark from the wood.

Since it had proved difficult to prepare sections for microscopic study from such injured regions of large trunks and branches on account of the fact that the injured bark usually drops off before pieces small enough for fixing and sectioning can be cut, suitable sized pieces were prepared from the basal parts of some of the injured one- and two-year-old shoots in the two younger apple orchards. Pieces of typical examples of such shoots were fixed and infiltrated for sectioning at intervals until the latter part of May, and will be made the chief basis for a subsequent report on the histological modifications resulting in crown-rot and certain types of cankers.

By the first part of May it became evident that most of the larger areas of injured bark in the crotches of the apple trees were dying. Various sized brown spots appeared on the outer surface of the most severely affected regions and it was found that these places of external browning were only an extension of the internal discoloration of disorganizing phloem. By the latter part of May many injured

areas both in the main crotches and around the basal ends of ascending shoots on large branches had died completely, and around the periphery of the region a thin callus ridge had formed under the bark. In cases where the affected areas extended some distance up the branches above the crotch the general appearance was surprisingly like that of ordinary cankers, because the dead area had become sunken and usually a fissure had begun to form around them like that shown in figure C on Plate XVIII and figure B of Plate XI.

The wood underneath the injured bark had become very much stained. Even in cases where the injury was not severe enough to cause the death of the outer bark, the wood was stained to a considerable depth. Many of the shoots a centimeter or more in diameter had the entire wood cylinder stained a rusty or dark brown in the affected region in case the bark injury had been severe all around their bases. In instances where the bark was injured chiefly on one side, only that half of the wood cylinder had become stained. It appeared as though there had been a diffusion of a stain or of an active discolorizing agent from the disorganizing phloem into the adjoining wood, very much like that observed many times in a number of orchards during early summer of 1911. The crotch injuries found in a Sodus orchard discussed on page 277 were apparently later stages of this type of injury.

Radial clefts and loosening of bark occurring together.— On a number of thrifty young maple trees from about 5 to 15 years old, along some streets in the western part of Madison, the bark alone and on others both bark and wood were cleft open during the first week of January. The clefts were mostly on the west side, even though some of the trees were along streets going north and south, but since that portion of the city is not closely covered by houses the speed of the west wind is checked but little. The bark on a few of the trees on streets going north and south was cleft either on the north or south side. None of the bark appeared to be loose when examined in January shortly after the occurrence of the clefts, but possibly that was due to the fact that the trees were frozen solid. They were re-examined in early spring and found to have loose bark on both sides, as well as some distance above and below the ends of the clefts.

The clefts varied in length from about 1 to 6.5 dm. and were most common on *Acer platanoides* and *Acer Negundo*. In cases where the clefts in the bark were short the wood underneath was not cleft but in those which were 3 dm. or more in length the wood was usually also cleft more or less. On some vacant land near the western edge of the city was a small clump of *Acer Negundo*, on the west side of which was one having the bark and wood both cleft. The cleft in the bark was 6.4 dm. long and was entirely closed in early spring while the sap was flowing, but by the latter part of May it stood open about a centimeter in the middle. The tree was sawed off on May

28 and short sections were taken from the typical regions and preserved in alcohol until they could be photographed. Figures 1 to 7 on Plates XXVIII and XXIX show sections of some of these injured regions.

Figure 1 is a section about 15 cm. above ground and 2 cm. below the lower end of the cleft in the bark. Its greatest diameter is 7.6 cm. In a section taken about 3 cm. nearer the ground there was but a trace of loosening of the bark, while in one taken 2.5 cm. above 1 the loosened area is wider and there has been an appreciable growth of callus along one edge. In the section shown in figure 1 the bark was not entirely loose; the injured region in the inner phloem seemed to offer slight resistance to the removal of the bark. The isolated bark was almost of normal color in figures 1 and 2 except at the margins of the cleft of 2. In figure 3 which was taken 2 cm. above 2, the loosened bark was slightly discolored and seemed to be nearly dead. The cleft in the wood shown in figure 3 to begin near the cleft in the bark and extending toward the pith through two annual growths may also be seen in figure 2. In figure 4 the bark above had died while that below the cleft was still partially alive. Figure 5 is taken above the middle of the cleft and shows the typical appearance of the region of maximum injury of both bark and wood. The loose bark is entirely dead and stands out away from the wood owing to the callus growths around the periphery of the wound and to the entire lack of adherence between the bark and wood. At the lower left of the figure some regeneration had occurred on the surface of the exposed wood.

In the region of the trunk about midway between the ends of the cleft in the bark the wood had been split through the pith to the inner side of the bark on the opposite side, but leaving the bark uninjured. A rather conspicuous ridge of new wood had developed over the end of the wood cleft; it was about as thick as the callus growth at the lower left margin of the loose bark shown in figure 5.

Figure 6 is taken about a centimeter above the upper end of the bark cleft and 15 cm. above figure 5. Here as in figure 1 no cleft resulted in the wood and the partially loosened bark was still alive. Figure 7 is of a section 3.2 cm. above that shown in figure 6 and about 5 cm. below the main crotches. The strip of injured bark is slightly wider at this point but is of normal color and seems to have grown in *thickness* by the development of new wood on the inner side of the bark against last year's growth.

As these figures plainly show, the increase in the diameter of this tree trunk in 1911 was nearly as much as that of any two previous seasons and therefore the bark had to increase enormously in area to adjust itself to the unusual increase in wood growth. The field observations on fruit trees also seem to show that bark on tree-trunks which increase unusually in diameter during one summer is most

subject to winter-injury while that on those growing at a more moderate rate may be practically immune.

Further observations on apple trees experimentally injured by low temperature.— The three remaining trees which had been treated with a freezing mixture on September 14, 1911, in a seedling orchard at Geneva, were re-examined on June 3, 1912, and found to have changed much in appearance. (See page 279.) Tree 1/25 had sparse and undersized leaves which were of normal color. The tree bore a few small fruits. Many of the distal portions of branches and numerous small spurs had died back and had large numbers of pycnidia of Cytospora broken through the periderm. The branches and leaf area had apparently been reduced by a shortage in the water supply.

Circular "pit-cankers" of various sizes surrounded the numerous "shot-holes" which were made by a bark beetle (Scolytus) a few days after the trees had been subjected to low temperature. The dead pits varied from about 4 to 14 mm. in diameter and most of them had been delimited from the live tissues around them by newly formed cork layers. However, quite a number of the largest ones on the stem and main branches and many of those on the abaxile side at the bases of twigs and spurs had failed to form new cork layers between the dying bark and the wood, and thus resulted in the formation of small circular pits circumscribed by a fissure as shown in figure 8 on Plate XXIX.

The remaining bark on the basal part of the stem had died and the wood underneath had become discolored nearly to the pith. The other wood in the girdled region had a normal color to within about 5 mm. of its outer surface. A thin callus had formed along the upper edge of the girdle.

Tree 2/9 was nearly dead; practically none of the last year's buds had leafed out although the branches had died back only about half way to the main crotches. Numerous small adventitious shoots had arisen on the living portions of the stem and main branches. The leaves on these shoots had a normal color but they were much curled and distorted by aphides.

The pit cankers were more commonly of the larger type and extended to the wood, although there had been sufficient growth to cause their delimitation from the surrounding bark by fissures.

The remaining bark around the base of the trunk had died and the wood underneath it was not only stained to the pith but partially decayed and permeated by the mycelium of some fungus. The other portions of wood had a normal color to within about a centimeter of the exposed outer surface. Practically no callus had developed along the upper limit of the dead girdle. Strips of bark from 1 to 5 cm. wide along both sides of the slits made before the tree was frozen, were partially loose and dead, with numerous pycnidia of

Cytospora bursting through its periderm. The same fungus was also fruiting on the dead portions of the branches and twigs.

No additional bark had died at the basal end of the trunk of tree 5/6, and a thick callus had formed around the old wound. The tree had a normal appearance and seemed to be growing nearly as well as the untreated trees around it.

The pits in the bark around the beetle holes were very small and shallow. They had been delimited by cork layers and none were found to reach the wood.

Some additional observations in the Clyde orchards.— The orchards which were discussed on pages 268-270 were visited again on June 18, and August 7, 1912, and found in good growing condition. The callus growths around the winter-injured places of the trees which had had veneer protectors around the trunks had crowded the grafting wax towards the center of the wound and appeared normal.

In the other orchards the growth of callus around the injured regions had also been considerable, as may be seen in figure C of Plate XI. The roll of callus surrounding the wound is thick and normal, and although the tree had been more than half girdled it looks like its uninjured neighbors. As far as could be judged by the removal of a small portion of the wax, no rot organisms had entered the dead wood. It appears as though even such severe wounds may be wholly covered on small trees in the course of three years.

The sprouts which had grown from stumps of completely girdled trees were not as promising as it was thought they would be; it would probably have been better to replace them by new trees

A few trees in this orchard were injured during the winter of 1911–12, but on none of them was the bark cracked open. They were more typically canker-like injuries. On the southwest side of several of the Baldwin trees growth had been practically negligible over certain irregular areas, usually of considerable length, while on other parts of the trunk it had been considerable. The place of transition from the normal to areas of negligible growth was distinctly marked by lines, as shown in figure B on Plate XI. The area of no growth or the depressed region in this case, extended from near the ground almost up to the first branches, and was broadest but least marked at the crown of the tree. The " sunken " bark still had a green color *externally* and contained much live tissue on June 18. It was found to have some discoloration in the phloem region but much more in the inner cortex. This tree had not been visibly affected during the summer of 1911. On August 7 the entire outer surface of the depressed region was brown and further growth had made the fissure wider than it appeared in the above figure. By removing the dead portions of bark it was found that the injury had extended only to the phloem in most cases and that only here and

there were dead spots as deep as the wood. Cork layers had delimited the dead from the living parts of bark.

Small patches of internally injured bark were also found in some crotches of this and various other trees in the same orchard. Many of the upright shoots which so commonly originate from the larger branches on closely pruned trees, also had the phloem more or less disorganized and the wood slightly stained about their bases, although no trace of the injury could be detected before most of the cortex had been removed. The histological features of such injuries and the changes occurring in them during spring are very interesting and will be discussed in another paper.

Further observations in a Weedsport orchard.— When seen again on July 23, 1912, the injured Baldwin trees in the Weedsport orchard described on page 265, and even those which had appeared uninjured, had not grown very well. They all looked decidedly scrubby and stunted. Only a few of the sprouted stumps had been left and several of them had been "winter-killed." Nearly all of the stumps had been replaced by new trees which seemed to be growing nicely. The Ben Davis trees, however, had grown remarkably well, as may be seen in figure B on Plate XIII which is taken down a diagonal row where all the Baldwin stumps had been replaced by new trees.

Since the injured Baldwin trees had not grown at a normal rate the callus growths were also smaller and had made less progress in the process of covering the exposed wood. No additional injuries had apparently occurred in the callus growths of trees injured in winter of 1910–11, nor was any found on other trees of either the Baldwin or Ben Davis varieties.

GENERAL CONSIDERATIONS AND DISCUSSION.

THE CAUSES OF CROWN-ROT.

Introductory.— Although the foregoing observations go to show that initial injuries which eventually result in crown-rot and canker occur *in winter*, and that certain environmental factors and conditions of trees at the close of a vegetative season are in some way related to the occurrence of the diseases, they afford only circumstantial evidence as to the factors or forces actually causing the injuries and the disintegration and rot which follow.

The bark of trees may be injured artificially in various and sundry ways and still give rise to results that may be very similar to each other and to some occurring in nature, but that after all can only be suggestive. If the factors of the environment are not thoroughly studied and sifted to assist in the *selection* of the causal ones, the significant factors actually operative in nature in the production of a disease under consideration may be overlooked. In an endeavor to explain the natural phenomena by means of an agent assumed to be the cause, similar results may often be artificially secured. For

example, gummosis may be produced in various ways, but that does not show that in *nature* it is actually due to *any* of the agents that may have been used to induce it artificially. The first requisite in the investigation of a disease of plants is a thorough study of the environment in relation to the life and seasonal history of the host and the selection for experimentation of the most likely environmental factor or factors and conditions of the host that when combined may result in the disease. That the selection of the chief causal factors is often very difficult is attested by the numerous failures reported in endeavors to make *natural* inoculations on plants with what was thought to be the real cause of disease.

Fungi not the first cause of crown-rot.— In a former paper it was shown that crown-rot had been attributed to various causes by different authors; many suggesting winter-injury as the cause and others fungi, etc. The observations recorded in the present paper show that winter-injury is the first cause, or more accurately that the primary injuries *occur during winter*. The fact that fungi nearly always appear on affected areas in the summer following the time of injury, while some bark is still partially alive and sometimes found exuding discolored "sap," has doubtless given rise to the idea that fungi are the cause. But since fungi seem to be confined to dead areas or to dead spots in severely winter-injured areas of bark it seems more logical to hold, at least until the matter can be more definitely determined, that they are only the agents of decay. In the case of the wood-rotting fungi found in connection with this disease a similar conclusion is reached, because the wood they invade is usually only that which had been stained by the after effects of winter-injury and that killed by exposure.

Can alkali be the cause?—The somewhat plausible assumption that crown-rot is due to an excess of alkali[1] in the soil in some sections of the west where vegetation is apparently often killed by alkali, seems rather unlikely in view of the fact that a very similar disease is equally common in regions where alkali is not present; but more especially in view of observations made by Headden[2] in the same alkali sections, which show that the roots of typically crown-rotted trees at some distance away from the "corroded trunk" are usually normal. It would seem that the more delicate peripheral roots and root-hairs of such a tree would be killed by the alkaline soil solution before the tree trunk could be "corroded" at the surface of the ground.

Arsenic from spray mixtures probably has no relation to the disease.— A little more might be said here about arsenic as the causal agent in relation to this disease although much of the pertinent matter was discussed in a former paper.

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[1] E. D. Ball. Is arsenical spraying killing our fruit trees? *Jour. Econ. Ent.* 2:142–48. 1909.

[2] W. P. Headden. Arsenical poisoning of fruit trees. Colo. Agrl. Expt. Sta. Bul. 157:1–56. 1910.

It was pointed out before that crown-rot occurs both in sprayed orchards and in those which had *never* been sprayed; that arsenic is a normal constituent of the soil and often occurs in fairly large quantities and is therefore taken up by plants. Attention was also called to the fact that herbaceous plants grow about crown-rotted trees, as is even shown in some photographs used by Headden. Ball and his associates[1] have more recently shown that large quantities of arsenicals used in spray mixtures may be allowed to stand in contact with the bark of apple trees and be poured about their roots without resulting in harmful effects in one season. On the other hand Swingle and Morris[2] have found that some arsenic compounds are more or less injurious when held in contact with wounded bark of apple-tree branches for some time. But some of their methods are objectionable because the excessive moisture and lack of proper aeration may induce hyperplastic growths and thus admit solutions which probably could not have penetrated the normal cork layers of the bark.

When plants absorb salts containing a poisonous element they are not necessarily injured; especially is that true of trees where so much of the unessential matter absorbed is stored in the non-living cells of the wood. For example, copper is one of the most active plant poisons known, so deadly in fact that it is not advisable to use water distilled from copper vessels when making culture solutions, yet copper is absorbed in the soil solution by plants and may even be stored in enormous quantities. In the vicinity of an abandoned copper mine Lehman[3] found that herbaceous plants contained from 83.3 to 560 mg. of metallic copper per kilogram of dry weight, while the different parts of a nearby cherry tree contained from 8.75 to 112.5 mg. per kilogram of dry weight.

MacDougal[4] also notes the presence of large quantities of *metallic* copper in wood and other cells of *Quercus macrocarpa.*

The chief evidence that has been advanced to show that arsenic causes crown-rot is the fact of its presence in such trees. But as arsenic is also present in normal trees and other vegetation that evidence is worthless; especially when it is borne in mind that trees may store large quantities of poisonous substances without being injured.

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[1] E. D. Ball, E. G. Titus, and J. E. Greaves. The season's work on arsenical poisoning of fruit trees.
Jour. Econ. Ent. 3:187–97. 1910.

[2] D. B. Swingle and H. E. Morris. A preliminary report on the effects of arsenical compounds upon apple trees.
Phytopath. 1:79–93. 1911.

[3] K. B. Lehman. Der Kupfergehalt von Pflanzen und Thieren in kupferreichen Gegenden.
Arch. Hyg. 27:1–17. 1896.

[4] D. T. MacDougal. Copper in plants.
Bot. Gaz. 27:68–69. 1899.

Low temperature and excessive or late growth as factors in production of crown-rot.—As stated above these factors have not been experimentally demonstrated as causes of the disease but their causal relation was chiefly inferred from observations made in a large number of affected orchards. The observed facts show that the initial injuries which result in crown-rot occur in winter and that rapidly grown trees are most subject to the disease; they indicate that bark in certain stages of its life history is more susceptible to the injury than in others, and also that the increase in diameter of a tree trunk in relation to its former diameter, as well as the premature checking of bark growth, probably have a causal relation to the occurrence of the injuries.

According to Göppert[1] bark on trees and shrubs is cleft by the drying out of winter-injured bark after thawing and not by the freezing of abundant sap as is commonly held; and that clefts in crotches are caused by the wind while the tissues are frozen and brittle. These injuries are said to be especially common on Prunus and Pyrus.

He found that frequently injuries occurred in the medullary rays and presumably in the inner phloem for he stated that in case the affected parts survive, discolored tissues which are subsequently covered by new annual rings, mark the year of injury. From his observations and remarks made about those of several earlier investigators, it seems as though he had in mind appearances like those shown on Plate VI of the above paper on crown-rot, and the thin discolored line on the left side of Plate XX and figures 1, 6 and 7 on Plates XXVIII and XXIX of the present paper.

Göppert held that plants are not susceptible to winter-injury because they contain a superabundance of sap but on account of their stage of development or state of vitality.

Some of the older observations and experiments on this phase of the subject are very interesting. They are to be found in both horticultural and botanical literature. A few of the more pertinent ones, with the conclusions reached, are worth noting on account of the light they throw on the above field observations and because of the diversity of opinion regarding factors involved in the production of winter injuries.

W. H. de Vriese[2] in a discussion on "Some principles of vegetable physiology, bearing on the culture of plants" attributes clefts in trees to the absorbing action of roots in winter: "the rising fluid ascends in trunks of trees and often causes large trees, the expansion of which is prevented by the cold, to split from top to bottom."

[1] H. R. Göppert. Ueber die Wärme-Entwicklung in den Pflanzen, deren Gefrieren und die Schutzmittel gegen dasselbe. pp. XVI+273. 1830.
Breslau.

[2] W. H. de Vriese. Some principles of vegetable physiology, bearing on the culture of plants.
Gard. Chron. Agrl. Gaz. 1854:597. 1854.

During the cold weather of January and February, 1855, numerous low-temperature clefts in trees in and around Berlin reopened, and Caspary[1] made a study of the forces concerned in their production. Early winter had been mild and rainy, but about the middle of January severe cold weather began and the temperature continued below freezing with an occasional freezing rain, until the latter part of February. Measurements of many trees and their clefts were made and the wind and weather records were closely followed through the cold period.

Caspary concluded that clefts in tree trunks occur without reference to the points of the compass and that Göppert's view concerning the relation of the wind as a causal factor can therefore not be correct. He observed, however, that only trees along roads and about the edge of forests are cleft while those in the interior of forests were not cleft.

Since it had been shown by others that after ice is once formed it contracts on a further lowering of the temperature, Caspary maintained that clefts occur in tree trunks as a result of the contraction of the wood, and not because of expansion resulting from ice formation in their interior as many believed. If clefts were formed owing to expansion resulting from ice formation they would close again when the temperature sinks below the freezing point of tree-trunks because ice has a very high coefficient of contraction, but as a matter of fact they open wider.

In a final summary he states that clefts result in introduced annual plants and shrubs during the first severe frost of a season, and that they are caused by the expansion of the abundant sap while freezing, especially in the cambial region; and that such clefts may occur on perfectly normal plants. However, in native trees clefts occur at lower temperatures and are said to be chiefly due to the excessive contraction of the peripheral wood, although in case of large trees in part to the differences in the temperature between the interior and exterior of the trunks. The rupture is said always to occur at the weakest point, determined by the location of decayed parts or wounds.

According to de Jonghe[2] clefts are partially due to sudden changes of temperature in spring which are said to "cause a reflux of the ascending sap," but chiefly to "the sun's rays which cause the bursting of the bark and occasion the splitting." He says that the "rents are always on the side next the sun and never on the east, north, or northwest sides." He held also that "In general, sun-strokes are more common on trees growing in a strong, moist soil, than in one that is light and dry."

In a second article, first published in the Echo de Bruxelles, de Jonghe[3] makes some further additions to his former observations.

[1] R. Caspary. Ueber Frostspalten.
Bot. Zeit. 13:449–62; 473–82; 489–500. 1855.

[2] de Jonghe. Sun strokes.
Gard. Chron. Agrl. Gaz. 1856:213. 1856.

[3] de Jonghe. The sun-strokes in pear trees.
Gard. Chron. Agrl. Gaz. 1856:230. 1856.

He says that sun-stroke is the most destructive disease of pear trees. "The tender, smooth bark of a growing pear tree, being not yet hardened, when struck directly by the solar rays, separates longitudinally from the alburnum to the extent of from two to five inches. The bark cracks in the middle, and its edges curling up, it affords a refuge for insects, which take up their quarters there and contribute by their biting to increase the size of the wound, and to produce a canker which most frequently causes the destruction of the tree." He advocates the covering of the tree stems to protect them from the sun's rays, as is also done by some of our modern horticulturists.

Caspary[1] quotes de Jonghe's last article in full and calls attention to some cases of low-temperature injuries which result in the separation of the bark from the wood, but attributes them to sudden freezing of the sap in the cambial region in spring.

In a further contribution to the cause of wood clefts in trees Caspary[2] confirmed his earlier findings in part by experiment. He found that the width of the clefts is proportional to the degree of cold; and that clefts in smaller trees will open quicker when the temperature becomes low, and close sooner when the temperature rises than those in larger ones. He also noted that old clefts reopen when the temperature is only a few degrees below freezing while new clefts do not form until a considerably lower temperature is reached.

The circumferences of short disk-like sections of tree trunks were carefully measured and then after some of them had been cut radially from the bark to the center with a saw, they were exposed to different temperatures and remeasured. The radial saw cuts which had closed on removing the saw were found open when the temperature had sunk a little below freezing, and two uncut sections were cleft over night by a temperature of — 7.2° C.

Measurements showed that the contraction and expansion of these sections as well as the opening and closing of the radial clefts followed the temperature changes just as the dimensions of the circumferences and clefts did in trees: when the temperature rose their circumferences increased and the clefts closed, while lower temperature decreased the circumferences and opened the clefts. He also found that the circumference of the bark changed more rapidly than that of the wood cylinder.

From these results Caspary concludes that the coefficient of expansion of tree trunks is even greater than that of ice, zinc or iron; and, that trees are cleft because their circumferences decrease more rapidly than their radii when the temperature is lowered.

[1] R. Caspary. Bewirkt die Sonne Risse in Rinde und Holz der Bäume? *Bot. Zeit.* 15:153–56. 1857.

[2] R. Caspary. Neue Untersuchungen über Frostspalten. *Bot. Zeit.* 15:329–35; 345–50; 361–71. 1857.

Nördlinger[1] discusses some of the effects of a cold snap which occurred during the first week in September, 1877; he finds that the bark of many young trees was injured and on others shoots were killed back. In the spring of 1878 fungi appeared on the killed bark and the shoots. Injuries were evident in spring as brownish red spots, especially around the bases of twigs and spurs. Some shoots were discolored only on the sunward sides.

Nördlinger concludes that vegetative activities must continue later at the bases of shoots and twigs, perhaps owing to the presence of the food materials usually stored in such places. Most of the shoots that had been severely injured at their bases subsequently died. On older structures the injurious effects were usually proportional to the size of the injured areas.

He holds that R. Hartig's contention that such crotch-cankers are due to spring frosts is erroneous, as may be seen by the examination of cross-sections and also on account of the fact that thousands of cases occur high up in trees and in locations where spring frosts could not have been harmful. He thinks it more likely that the tissues of such injured places entered winter in an immature condition and were injured on that account.

In a brief note in the Gardener's Chronicle signed by A. D.[2] it is stated that in December, 1887, a few old plants of Japanese chrysanthemum were found having the bark loosened on their stems, above the ground. The growth of the plants had been checked by drought and they grew again in fall. The bark was thought to have been loosened by hoarfrost fractures.

The measurements of tree trunks made at different temperatures during last winter and spring confirm Caspary's observations in showing that the lowering of temperature decreases and the raising of temperature increases the circumference considerably. From a few experiments done last winter with cross-section of large maple branches and trunks of apple trees it was found that the circumference of isolated rings of bark decreases appreciably more than that of the cylinders of wood when subjected to the same low temperature and would thus apparently lead to an increase in bark tension.

It is a well known fact first clearly set forth by Sachs in his Experimental Physiologie that tensions between different kinds of tissues result from differences in their rates of growth. The existence of tensions between the bark and wood of a fruit tree can be readily demonstrated by slitting the bark. This method may be used to show that there is often quite a variation in bark tension of different trees as well as at different heights on the same tree.

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[1] Nördlinger. Die September-Fröste 1877 und der Astwurzelschaden (Astwurzelkrebs) an Bäumen.
Centbl. Gesam. Forstw. 4:489-90. 1878.

[2] A. D. Effects of recent frosts.
Gard. Chron. 2:691. 1887.

Kraus[1] measured at various heights the bark tensions of many trees, shrubs and herbaceous plants by isolating rings of bark and replacing them to find the amount of contraction that had resulted. Although the method gives neither quantitative nor even accurate comparative results, it shows beyond question that there are regions of maximal and minimal transverse bark tension at different heights on a trunk.

In a one-year-old shoot or stem the transverse tension between the bark and wood was found to increase from the tip downward so that the basal internode had the greatest bark tension. As growth continues the tension increases up to a certain point and then the bark cells divide and grow, and thereby reduce the tension until further growth increases it again. This process is said to begin at the oldest internodes and to pass gradually towards the distal end.

In some measurements of transverse tension taken during winter considerable variation was found in the distribution of maxima and minima on the stems and branches of trees, but it usually began with zero at the distal end and increased to the maximum on the largest branches before reaching the main crotches and afterwards increased to a second maximum somewhere about the crotches. In some instances the bark tension of stems decreased towards the ground and in others it was found to increase to another maximum at the surface of the ground or about the upper roots. Kraus holds that transverse tension develops in the bark and gradually increases to a maximum because the bark lags more and more in growth until at a certain stage in its life history its outer portion ceases growth and is ruptured, resulting in the roughened bark typical for the species. The cortical parenchyma seems to be tardiest in tangential growth during the first few years and therefore suffers the greatest transverse or tangential strain, until after a certain number of years it reaches a maximum which is followed by a more rapid growth and a consequent reduction of the tension.

It is thus seen that transverse bark tension has seasonal and life history maxima and minima which may change their positions up and down tree trunks and branches. It was also found that there is a daily periodicity in the tension with a maximum at night and a minimum about 2 P. M. It is held that the daily periodicity cannot be due to root pressure nor to differences in transpiration because cut branches immersed in water still exhibited the same periodicity. Neither do temperature variations appear to affect the daily periodicity as long as they do not go below vegetative requirements. But when a branch was placed in the dark about noon (the period of minimum tension) the maximum was reached in one or two hours and remained so till exposed to light, when the normal periodicity was again resumed.

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[1] G. Kraus. Die Gewebespannung des Stammes und ihre Folgen. *Bot. Zeit.* 25:105–19; 121–26; 129–33; 137–42. 1867.

Swaying is said to decrease transverse tension at the point of bending and is followed by an increase in the rate of growth at that region.

Kraus also found many very small longitudinal clefts in the smooth outer bark of Acer, Æsculus, and Salix, during winter and extending as far as the cambium in some cases. The clefts are attributed to transverse tension.

From this work it appears highly probable that toward the end of a vegetative season the bark tension on a tree which increased much in diameter as compared with its former diameter, may be much greater than on one having made but little growth. It is also apparent that in case vegetative activities are inhibited prematurely in fall or continued in full vigor abnormally late owing to uncommon environmental conditions, the seasonal maximum bark tension may be retained through the following winter. The bark on trees entering the dormant season with high growth tension maxima at certain regions of trunks and branches, is subject to excessive strains in the high pressure areas when the temperature drops suddenly through many degrees; that would be true regardless of whether the temperature sank low enough to be injurious to perennial plants or not.

The above field observations show that the initial injuries resulting in crown-rot and cankers usually occur at points which are in close agreement with the location of the regions of maximal bark tension found by Kraus, and in view of the researches of Sorauer which seem to show that low temperature injury is often due to the tensions induced rather than to the degree of cold, it appears probable that initial injuries of this type are due to the combined effect of tensions resulting from differences in growth rate, their increase by low temperature, and the additional strain caused by bending in time of strong winds.

In the case of the experiment discussed on pages 32 and 44, the temperature was probably too low to enable one to distinguish between the effect of the degree of cold and the tensions induced. It seemed strange, however, that some bark was loosened on a tree on which it had been slit; yet it does not show that the old notion of slitting the bark on the trunks of rapidly growing trees is erroneous, for it may be that if slit at certain times and allowed only time enough to heal the wounds before the dormant period arrives some injuries due to excessive bark tensions might be avoided.

The wind as a factor in causing crown-rot.— As was often noted in the field observations the relative wind exposure to which different orchards are subjected seemed to make a decided difference in the amount of winter-injury resulting. The injuries occurring on tree trunks above ground and below the crotches were usually oriented with reference to the prevailing wind. In case the location of the injuries was not determined by the prevailing wind they were nevertheless on the *same side* in any particular orchard or locality, indicating that the wind may have come from that direction during the

time the injury occurred. It appears significant also that in instances where trees had been banked with soil the injuries occurred just above the soil while on unbanked trees it usually occurred at the surface of the ground. But this probably does not hold when the ground is not frozen at the time of injury for in that case any bending that may result from strong winds would probably occur at the surface of the ground or even below it, and result in injury at the root crotches.

Göppert[1] maintained that the wind is involved in the production of winter injuries, especially the north wind, for injuries were sometimes found confined to plants in certain strips or zones of localities. Excessive evaporation, an additional lowering of the temperature due to wind he believed, were frequently the causes of killing back of shoots and branches of trees.

Bernbeck[2] subjected various plants to wind rates as high as 31.3 miles per hour and obtained some very striking results. He found that transpiration was proportional to the wind rate and to the amount of bending or swaying undergone by plant structures, and that the excessive loss of water ceased when bending was eliminated. His results with lignified plant structures are especially pertinent to this discussion.

A potted plant of *Fagus silvatica* was exposed to a wind rate of 31.3 miles per hour (14 m. per second) and in about 10 days brown spots had developed in the bark, where both the cambium and cortical perenchyma had been killed. Many cell walls are said to have been ruptured. On a potted plant of *Picea excelsa* exposed to the same wind rate a few hours, the bark on the swaying twigs was cleft open at a number of places on the windward or convex side, exposing the bare wood. *Pinus silvestris* and *P. austriaca* sustained similar wounds on the convex sides of twigs when subjected to the same treatment. The clefts closed and became invisible when the normal environment was restored. *Ulmus effusa* was also injuriously affected, but in this case the uninjured areas of bark remained alive, and after a few weeks the damage done to the woody parts had been practically repaired by growth.

On a potted specimen of *Alnus incana* given the same treatment, the bark was injured in many places after several days' exposure. Some injuries occurred also in the wood cylinder but were not evident externally. Knotty masses of callus developed on the injured regions. *Quercus pedunculata* was similarly affected after 6 days' exposure and also developed knotty enlargements about the old wounds in the course of the summer. Thin lignified twigs of *Ulmus effusa*, *Alnus glutinosa*, *Fagus silvatica*, *Picea excelsa*, and *Larix europaea* were exposed in duplicate (one set being firmly fixed and the other allowed

[1] *L. c.* pp. 58–61.

[2] O. Bernbeck. Der Wind als pflanzenpathologischer Faktor. Inaug. Dissertation, Bonn. p. 116. 1907.

to sway) to an air current of 22.3 miles per hour (10 m. per second), and after 3 to 6 days all of the loose twigs had died back more or less while the fixed ones remained apparently normal to the end of the experiment. That is, perfect rigidity seems to afford total immunity from wind injuries, while swaying or bending result in injury.

In order to distinguish between the swaying and drying effects of strong winds the experiments were repeated, the plants being kept wet by means of a spray of water. Similar results were obtained, and it was found that the bending of plant structures has a marked influence on the transpiration rate of both leaves and twigs even when the surrounding air is saturated with moisture.

When the wind rates used in these experiments are compared to those frequently occurring during the dormant period of fruit trees they are not very high, and their pressure is therefore also lower than that to which our trees are often subjected. The following table taken from an article by Keller[1] shows the pressure resulting from different wind rates.

TABLE IV.—THE RATE AND RESULTING PRESSURE OF THE WIND.

DESIGNATION.	Miles per hour.	Pressure per sq. ft.	DESIGNATION.	Miles per hour.	Pressure per sq. ft.
Fair breeze	5	0.126	Stiff breeze	18	1.634
	6	0.181		19	1.821
	7	0.247		20	2.018
Fresh breeze	8	0.323	Very brisk wind	25	3.155
	9	0.408	High wind	30	4.547
	10	0.505		35	6.194
	11	0.610	Very high wind	40	8.099
	12	0.726	Gale	45	10.260
	13	0.852	Storm	50	12.684
	14	0.988	Great storm	60	18.310
Stiff breeze	15	1.135	Hurricane	80	32.800
	16	1.291	Tornado	90	40.500
	17	1.458		100	50.000

A wind blowing at the rate of 25 to 40 miles per hour is not at all uncommon in most regions of the United States and frequently a rate of 50 to 60 miles is maintained for some time.

Bernbeck's results are especially interesting when compared with the above field observations of 1911. Most of the injuries occurring during the winter of 1910–11 were accompanied by radial clefts in

[1] E. Keller. The hygiene of the small chemical laboratory. *Jour. Ind. Eng. Chem.* 2:246–51. 1910.

the bark at the region of severest injury, and the bark was loosened on the windward and sometimes also on the leeward side as shown on Plate VII. The wood was not cleft, and sometimes only the periderm and outer cortex were cleft and loosened. The trees had not been injured in extreme cold weather, because during that winter the injury occurred before the middle of January. However, the cases observed near Glens Falls were slightly different in that the injury involved a longer portion of the trunks and was sometimes confined to the region nearly midway between the ground and first crotches, as shown in figure B on Plate XIV. It seems as though the bending might have occurred higher up or over a greater length than it did in the western part of the State, possibly due to the frozen condition of the trees and ground at the time of injury. Since the location of the region of maximal bark-tension may determine the place of injury, it appears possible that the tensions were more widely distributed in this case.

When a late summer drought retards bark growth or its complete adjustment to the increased circumference of the new wood produced in early summer, smooth bark may not only have a high transverse tension when the winter or dormant season begins but its lenticels may also be in such a state of incompleteness as to permit excessive evaporation throughout the following winter, and especially during a windy winter thaw. The bark on trees in wet situations may be in a similar condition on the approach of the dormant season, owing to abnormally late growth of wood in mid-summer. In view of Bernbeck's observations and experiments which show that the bending of twigs and branches by the wind results in excessive loss of water and consequent injuries on the windward side of shoots, it is very likely that imperfect lenticels and a high bark tension increase the liability to such injuries. The type of bark injuries which occurred on smooth-barked, thrifty pear trees in the winter of 1910–11, and which resulted in much blackened bark on the west side of trees as described above for some Medina orchards, seems to be of this type. During the winter of 1909–10 a similar though less extensive injury developed on the south side of young pear, apple, plum and cherry tree trunks and ascending branches in the western part of this State; while in the Hudson River Valley about Poughkeepsie and Milton, the injury occurred on the north side of trees during the same winter. In the winter of 1909–10 as well as in that of 1910–11, partial or complete winter thaws occurred during strong winds. In the former the wind was very high from the south during several days of open weather in late winter in the western part of the State, and in the latter the wind was from the west in the same region during a January thaw. Such injuries are usually called "sun-scald" and are attributed to an injuriously high temperature induced in such bark by the sun, but since the injuries may also occur on the north

side of trees and on trees so situated that the sun rarely shines on their trunks the "sun-scald" hypothesis appears untenable, while the wind swaying and excessive evaporation theory of Bernbeck seems to afford an explanation of the observed facts. As stated before, more or less thickly scattered groups of cells in the inner phloem and inner cortex are injured first and sometimes all around a trunk or an ascending branch, but in severe cases the interspersed living groups also die; first on the windward side, and in extreme cases the entire bark subsequently dies on upright shoots. Such shoots are then said to have been "winter-killed." In the "sun-scald" and "winter-killed" types of injuries the bark does not sustain radial clefts but is frequently wind-checked after it dies. In case the initial injury in the phloem and inner cortex has not been severe enough to result in the typical "sun-scald" effect the bark on the windward side of trunks frequently dies only in patches during the summer, as is shown in figure C on Plate XVIII.

The injuries of last winter which included radial clefts, usually also involved the wood cylinder. In many of these cases the bark was not loosened. In considering the contraction of tree trunks (page 36) occurring during the time of injury it seems likely that the clefts, especially in cases where the bark had not been loosened, were mainly due to low-temperature contraction in the wood. Yet it appears probable that wind swaying was also concerned in the production of wood clefts which extended *through the entire wood cylinder* like those shown on Plates XX and XXIX, because it is inconceivable how tensions due simply to peripheral contraction could result in wood clefts extending far beyond the pith. In instances like the one shown on Plates XXVIII and XIX, where there was a combination of bark loosening and radial clefts in both wood and bark, the bark tension must have been high on the approach of winter. It would appear, then, that the chief difference between the winter injuries of the past two years involving radial clefts, is their occurrence at different temperatures. In the winter of 1910–11 the injuries occurred during only moderately low temperature and the bark alone was cleft; while last winter the temperature was very low during the time of their occurrence, and resulted in wood clefts also. In many cases of last winter the bark loosening did not accompany the clefts, presumably because the tension in the bark was but little in excess of that in the wood. But the wind was probably a factor in both cases.

Low temperature probably caused the bark injuries in crotches of young apple trees by increasing the bark tension due to growth. The wind seems to have had only a secondary influence in those cases since no clefts resulted. Nördlinger attributed crotch injuries to early cold weather and the immature condition of the tissues at such points.

The relation of growth and low-temperature tensions and the strain induced by high winds, to the initial injuries resulting in rots

and cankers on fruit and shade trees has been inferred chiefly from the environment of affected trees and from the type and location of the effect produced on them. The crown, "heart," and root rots which follow are doubtless due to fungi, principally of the hymenomycetous group.

SOME SUGGESTIONS OF ECONOMIC BEARING.

The field observations indicate that varieties of fruit trees which are subject to winter injuries of this type should be headed low regardless of the inconveniences which may be experienced in cultivation; also, that excessive and late growth should be prevented if possible. Perhaps windbreaks or some means to prevent young trees from swaying, may also prove of value in preventing the initial injuries. *Young trees which are growing rapidly or trees whose growth was prematurely checked by unfavorable conditions, so that they enter the dormant period with immature bark, ought to be carefully examined in spring and early summer for indications of loosened or injured bark. Such bark when found should be cut out with a sharp knife at right angles to its surface and the exposed wood, if still of normal color, covered with grafting wax or with tar paint if it is discolored or dead.*

REPORT

OF THE

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TABLE OF CONTENTS.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

COMPOSITION AND PROPERTIES OF SOME CASEIN AND PARACASEIN COMPOUNDS AND THEIR RELATION TO CHEESE.*

LUCIUS L. VAN SLYKE AND ALFRED W. BOSWORTH.

SUMMARY.

1. Object.— The work was undertaken to obtain more information regarding the compounds formed by casein and paracasein with bases, especially with Ca. Two compounds have been previously prepared, one neutral to phenolphthaleïn, containing 1.78 per ct. Ca (2.50 CaO), and the other, neutral to litmus, containing 1.07 per ct. Ca (1.50 CaO). Our main object was to learn if there were other compounds containing less Ca. Another purpose was to ascertain the composition of the substance formed in cheese which is insoluble in water but soluble in 5 per ct. solution of Na Cl.

2. Method of preparing casein.— Casein must be made base-free for use in such work. Preparations were made containing less than 0.1 per ct. of ash. The usual method was employed in part, precipitating separator skim-milk with dilute acetic acid, redissolving the washed precipitate in dilute NH_4OH, continuing precipitation and solution three or more times. Finally, the remaining calcium is precipitated from the ammonia solution as oxalate, the precipitate being removed by centrifuging and filtering, and the filtrate precipitated with dilute HCl. After washing free from HCl, the casein is treated with alcohol and ether, and after grinding and partial drying is dried over H_2SO_4 under reduced pressure. Analysis of such casein preparations agrees with the composition generally accepted, except in the amount of phosphorus and sulphur.

3. Preparation and composition of basic calcium caseinate.— The compound was prepared in two ways, (1) by decomposing $CaCO_3$ with casein and (2) by treating casein with a lime-water solution and neutralizing the excess with HCl, with phenolphthaleïn as indicator. The composition of the resulting compound was determined (1) by weighing the CO_2 expelled from $CaCO_3$, (2) by determining the Ca in the resulting casein compound and (3) by analysis of compound formed by treating lime-water solution of casein with acid until neutral to phenolphthaleïn. The different results agree closely, showing basic calcium caseinate to contain about 1.78 per ct. Ca (2.50 CaO), or 1 gram of casein combines with 9×10^{-4} gram equivalents of Ca.

* A reprint of Technical Bulletin No. 26, December, 1912.

(4) Acid or unsaturated caseinates of ammonium, sodium and potassium.— These compounds were prepared as follows: Ash-free casein is dissolved in alkali so that 50 cc. of $\frac{N}{50}$ alkali contain 1 gram of casein. This is neutralized with $\frac{N}{50}$ HCl, which is added in small portions, under constant agitation, until a permanent precipitate begins to appear, as shown by centrifuging a portion of the mixture in a sedimentation tube. This method enables one to detect the casein precipitated by 0.20 cc. of $\frac{N}{50}$ HCl. The point at which a permanent precipitate first begins to appear is noted and addition of acid is continued until all the casein is precipitated, which point is also noted. Three different casein preparations were used and numerous determinations were made. It was found that 1 gram of casein forms a soluble compound with each of the alkalis used when combined with amounts somewhere between 1.10×10^{-4} and 1.15×10^{-4} gram equivalents of alkali; or, 1 cc. of $\frac{N}{10}$ alkali combines with an amount of casein somewhere between 0.87 and 0.91 gram. The proportion of basic element in each compound is as follows: NH_4, 0.20 per ct.; Na, 0.26 per ct.; and K, 0.44 per ct. Such casein compounds contain the smallest known amount of base and it is suggested that they be called mono-basic caseinates.

Special preparations were made of mono-ammonium caseinate, the compound being isolated and prepared in dry form. This was found to have the composition called for by the previous results obtained with the volumetric work.

(5) Acid or unsaturated caseinates of calcium, strontium and barium.— When a solution of casein in a hydroxide of calcium, etc., is treated with an acid, the caseinate is precipitated by the chloride formed; this difficulty can be overcome by removal of the chloride through simple dialysis before the amount is sufficient to cause precipitation. One gram of ash-free casein is dissolved in 250 cc. of $\frac{N}{50}$ hydroxide solution and $\frac{N}{50}$ HCl is added until the first sign of a permanent precipitate appears, as shown by centrifuging a portion. The solution is then dialyzed to remove soluble chloride and then acid is again added until precipitation again occurs and another dialysis is made. Alternate addition of acid and dialysis are continued until finally the dialyzed solution forms a permanent precipitate with the addition of any acid. The results of many experiments agree in indicating the formation of two sets of compounds, mono-basic and di-basic, one set containing twice as much base as the other. In the di-basic compounds, 1 gram of casein requires between 2.2×10^{-4} and 2.3×10^{-4} gram equivalents of hydroxide to form a compound soluble in water but easily precipitable by even a small amount of a soluble chloride of calcium, strontium or barium. In the di-basic compounds, 1 gram of casein combines (a) with 0.44 to 0.46 gram Ca (0.62 to 0.64 CaO), (b) with 0.96 to 1.01 gram Sr (1.14 to 1.19 SrO), and (c) with 1.51 to 1.58 grams Ba (1.69 to 1.76 BaO). In the mono-basic salts, 1 gram of

casein combines with about 1.1 x 10^{-4} gram equivalents of hydroxides to form *insoluble* compounds, which are soluble in 5 per ct. solution of chloride of sodium, ammonium or potassium. This solubility is due to an exchange of bases; for example, insoluble mono-calcium caseinate is changed by treatment with solution of NaCl into soluble mono-sodium caseinate and $CaCl_2$, as shown by special experiments.

Special preparations were made of mono- and di-calcium caseinates, each compound being isolated and prepared in dry form. These were found to have essentially the composition called for by the previous results obtained with the volumetric work.

(6) Valency of casein molecule and molecular weight of casein.— On the basis of the composition of the basic calcium caseinate and mono-calcium caseinate, the former has a valency of 8. These relations indicate the molecular weight of casein to be 8888 and the equivalent weight 1111.

(7) Method of preparing paracasein.— Separator skim-milk is heated to 37° C. and treated with 0.12 cc. of rennet-extract (Hansen's) per 1,000 cc. of milk. The milk is allowed to stand until completely precipitated. The resulting curd is broken up by vigorous stirring, the whey removed and the precipitated paracasein washed freely with water. It is then dissolved in dilute NH_4OH, reprecipitated with acid and the operation continued and completed as in case of casein.

(8) Preparation and composition of basic calcium paracaseinate.— By the same methods of study, paracasein was shown to form with calcium a paracaseinate similar in composition and properties to that of basic calcium caseinate.

(9) Acid or unsaturated paracaseinates of ammonium, sodium and potassium.— In these compounds, 1 gram of paracasein combines with an amount of alkali somewhere between 2.2 x 10^{-4} and 2.3 x 10^{-4} gram equivalents in forming soluble compounds with ammonium, sodium and potassium, which are acid to both litmus and phenolphthalein. One cc. of alkali combines with 0.435 to 0.455 gram of paracasein. The percentage of basic element in each compound is, NH_4 0.40; Na, 0.52; and K, 0.88. The amount of each basic element in these paracaseinates is just twice that present in the corresponding casein compounds.

A preparation of mono-ammonium paracaseinate in dry form gave results agreeing fairly well in composition with the results obtained by volumetric work.

(10) Acid or unsaturated paracaseinates of calcium, strontium and barium.— Mono- and di-basic paracaseinates were prepared in the same manner as the corresponding caseinates and were shown to differ from them in having just twice as much of the basic element. In the mono-basic compounds, which are *insoluble*, 1 gram of paracasein combines with about 2.3 x 10^{-4} gram equivalents of hydroxide of calcium, etc.; in the di-basic, which are *soluble*, with about

4.6×10^{-4} gram equivalents. Their properties resemble those of the corresponding caseinates.

(11) Valency of paracasein molecule and molecular weight of paracasein.— The valency and molecular weight are shown to be one-half those of casein.

(12) Action of rennet-enzym on casein in forming paracasein.— When casein is treated with rennet-enzym, the casein molecule appears to be split into two molecules of paracasein.

(13) Composition of brine-soluble compound in cheese.— During the manufacture and ripening of cheddar and many other kinds of cheese, a protein is always formed which is insoluble in water but soluble in a 5 per ct. solution of NaCl. Former studies led to erroneous conclusions regarding its identity. Extended study shows that this substance is identical with mono-calcium paracaseinate.

INTRODUCTION.

The uncombined protein, casein, shows the characteristic property of an acid in combining with bases of the alkalis and alkaline earths to form salts and in decomposing their carbonates. The compounds thus formed, especially those with calcium, have been studied by numerous investigators, the more important contributions have been made by the following:

Hammarsten (Zur Kenntniss des Kaseins etc., Upsala, 1877);
Söldner (*Landw. Versuchs.-Stat.*, **35:** 351, 1888);
Courant (*Pflüger's Arch. Physiol.*, **50:** 109, 1891);
Timpe (*Arch. Hyg.*, **18:** 1, 1893);
Béchamp (*Bull. Soc. Chim.* (3) **11:**, 152, 1894);
de Jager (*Maly Jahresber. Thierchem.*, **27:** 276, 1897);
Salkowski (*Zeitschr. Biol.*, **37:** 415, 1899);
Kobrak (*Pflüger's Arch. Physiol.*, **80:** 69, 1900);
Osborne (*Jour. Physiol.*, **27:** 398, 1901);
Laqueur and Sackur (*Beitr. Chem. Physiol. u. Pathol.*, **3:** 193, 1902);
Van Slyke and Hart (Bull. No. 261, N. Y. Agr. Exp. Sta., and *Am. Chem. Jour.*, **33:** 472, 1905);
Long (*Jour. Am. Chem. Soc.*, **28:** 72, 1906);
Robertson (*Jour. Biol. Chem.*, **2:** 317, 1906);
Robertson (*Jour. Physic. Chem.*, **13:** 469, 1909).

Without going into details, it is sufficient for our purpose at this point to state that results have been reported in which compounds, formed by treating casein with calcium hydroxide, contain an equivalent of calcium oxide varying all the way from 0.8 to 3 per ct. (equal to 0.57 to 2.14 per ct. of calcium).

In the chemical laboratory of this Station, the relation of casein and paracasein to bases has been a subject of continued study for several years, especially in connection with changes taking place in the operation of cheese-making. The results here presented include

a careful revision of work published in previous bulletins of this laboratory with material extensions of the line of investigation.

Two compounds of casein and calcium have been generally recognized, one containing about 2.50 per ct. CaO (1.78 per ct. Ca), and the other about 1.50 per ct. CaO (1.07 per ct. Ca). We have found, in addition, two others, one containing about 0.31 per ct. CaO (0.22 per ct. Ca), and the other double this amount. Corresponding compounds are shown in our work to be formed by paracasein with calcium, and also by both casein and paracasein with ammonium, sodium, potassium, barium and strontium. A study of the methods of preparation and of the properties of these compounds is given in this publication; the ground covered is embraced under the following outline:

Part I. Casein and some of its compounds.
1. Method of preparing ash-free casein.
2. Preparation and composition of basic calcium caseinate.
3. Preparation and composition of unsaturated or acid caseinates.
4. Valency of casein molecule and the molecular weight of casein.

Part II. Paracasein and some of its compounds.
1. Method of preparing ash-free paracasein.
2. Preparation and composition of basic calcium paracaseinate.
3. Preparation and composition of unsaturated or acid paracaseinates.
4. Valency of paracasein molecule and the molecular weight of paracasein.
5. Action of rennet-enzym on casein.

Part III. Composition of brine-soluble compound in cheese.
1. Brine-soluble compound formed in cheese-making.
2. Identity of brine-soluble compound and monocalcium paracaseinate.

PART I. CASEIN AND SOME OF ITS COMPOUNDS.

METHOD OF PREPARING ASH-FREE CASEIN.

Casein that is to be used in studying its relation to mineral bases must be free from all such bases. The preparation of really ash-free casein is much more difficult than has been commonly assumed. The so-called chemically-pure casein furnished by chemical-supply houses usually contains 0.6 per ct. of ash. The preparations used in various investigations in which the ash content has been reported rarely contain less than 0.2 per ct. of ash and not infrequently as much as 0.6 per ct.

The principal basic element in casein preparations, as usually made, is calcium. The calcium in casein preparations is usually due to the presence of a compound of calcium and casein, containing 0.22 per ct. Ca (equal to 0.31 per ct. CaO), as we shall show later. This salt is insoluble in water but easily soluble in a 5 per ct. solution of sodium chloride, while base-free casein is insoluble in both water and the brine solution.

When casein is carefully precipitated by dilute acids from milk or from lime-water solutions of casein, the precipitate is apt to contain more or less of the above-mentioned calcium caseinate as well as base-free casein. The precipitation of this calcium salt occurs most readily when the usual precautions in precipitating casein from milk are most rigidly observed, that is, when excess of acid is avoided. We have examined casein preparations obtained from chemical-supply houses and have found that some of them are soluble in a 5 per ct. solution of sodium chloride to the extent of 50 per ct., or more, of their weight.

After trying different methods of preparing casein so as to contain a minimum amount of calcium, we have obtained the most satisfactory results by the method described below. We have been able to prepare casein containing only 0.06 per ct. of ash, consisting largely of calcium phosphate, derived from the trace of calcium not removed and the phosphorus of the casein molecule. The amount of calcium present in 5 grams of such material was too small to determine quantitatively.

Our method of preparation is to dilute separator skim-milk with seven or eight times its volume of distilled water and carefully add dilute acetic acid (6 cc. of glacial acetic acid diluted to 1 liter) until the casein separates completely, after which the clear solution is removed by siphon as soon as the precipitate settles. Distilled water is then added, the mixture stirred vigorously and the precipitate allowed to settle, after which the wash-water is siphoned off. More water is then added and the casein is dissolved by adding, for each liter of milk used, 1 liter of dilute ammonium hydroxide (6 cc. of strong reagent diluted to 1 liter). When the solution is complete, the whole is filtered through a thick layer of absorbent

cotton. The casein is then precipitated again with dilute acetic acid; the precipitate is allowed to settle, and is then washed, redissolved in dilute ammonium hydroxide, and filtered, the process of precipitation, washing, dissolving, etc., being repeated not less than four times. Finally an excess of strong ammonium hydroxide (10 cc.) is added and then 20 cc. of saturated solution of ammonium oxalate. The mixture is allowed to stand 12 hours or more. Calcium is precipitated as oxalate in very finely divided condition, too fine to permit its satisfactory removal by ordinary methods of filtration. Better aggregation of the precipitate can, however, be effected by means of centrifugal force. The centrifuged mixture is then filtered through double thickness of filter paper. The filtered solution is next treated with dilute hydrochloric acid (10 cc. of HCl, sp. gr. 1.20, diluted to 1 liter) until the casein is precipitated. The precipitate is washed with distilled water until free from chloride and is then placed on a hardened filter paper in a Buchner funnel, as much water as possible being now removed from the precipitate by suction. The mass is next transferred to a large mortar and thoroughly triturated with 95 per ct. alcohol. The alcohol is then removed by suction on a Buchner funnel and the casein is then again placed in a mortar and triturated with absolute alcohol. Most of the alcohol is removed by filtration and the casein treated twice with ether in a mortar by trituration, the ether being removed each time by means of suction on a Buchner funnel. The material is then placed in a large evaporating dish and spread out in a layer as thin as possible; it is allowed to stand 12 hours or more in a warm place; and is finally ground in a mortar until the particles pass a 40-mesh sieve, and is dried two days over sulphuric acid in a desiccator under diminished pressure.

Three preparations made in this way were found to show an ash content of 0.10, 0.09 and 0.06 per ct., respectively. These preparations were insoluble in water and in 50 per ct. alcohol; the first one was very slightly soluble in a 5 per ct. solution of sodium chloride, but the two others were not.

When one gram of these casein preparations was treated with 10 cc. of $\frac{N}{10}$ hydroxide of ammonium, sodium or potassium, and 90 cc. of water, a clear solution was obtained, the casein dissolving completely. When to this solution a minute amount of a solution of a barium, calcium or strontium salt was added, there developed promptly the opalescent appearance characteristic of casein solutions under such conditions.

Casein prepared in the manner described was analyzed, with the following results:

	Per ct.		*Per ct.*
Moisture	1.09	In dry substance:	
In dry substance:		Nitrogen	15.80
Ash	0.06	Phosphorus	0.71
Carbon	53.50	Sulphur	0.72
Hydrogen	7.13	Oxygen (by difference)	22.08

PREPARATION AND COMPOSITION OF BASIC CALCIUM CASEINATE.

The compound commonly known as basic calcium caseinate contains the largest amount of calcium in combination with casein. This is the compound that has been most frequently prepared and studied by investigators, beginning with Söldner (see references on page 312). Varying results have been obtained by different workers, the percentage of calcium ranging from 1.66 to 2.13 per ct. (equivalent to 2.32 to 2.98 per ct. CaO).

This compound can be prepared in two different ways: (1) By decomposing calcium carbonate with casein and (2) by treating casein with a solution of calcium hydroxide (lime-water).

Preparation of basic calcium caseinate by treating casein with calcium carbonate.— When casein is treated with calcium carbonate, the results of the reaction can be measured in two ways: (a) By weighing the carbon dioxide displaced, and (b) by determining the amount of calcium in the resulting compound. Both methods were used by us.

Casein prepared in the manner previously described was placed in the flask of a Knorr carbon dioxide apparatus and an excess of calcium carbonate suspended in water was added. The carbon dioxide formed in the reaction was run into weighed bulbs containing potassium hydroxide and the increase of weight due to carbon dioxide determined at the end of the reaction. The results are given in the following table.

TABLE I.— AMOUNTS OF CARBON DIOXIDE EXPELLED FROM CALCIUM CARBONATE BY CASEIN.

Amount of dry casein used.	Amount of CO_2 expelled.	Amount of Ca O (and Ca) for 100 grams of casein, equivalent to CO_2.
Grams.	*Grams.*	*Grams.*
10	0.1900	2.42 (1.73 Ca)
10	0.1980	2.52 (1.80 Ca)
5	0.1054	2.68 (1.91 Ca)
5	0.1003	2.55 (1.81 Ca)
Average	——	2.54 (1.81 Ca)

For the purpose of measuring the results of the reaction by determining the amount of calcium in the resulting compound, the casein was put in a mortar and thoroughly triturated with an excess of moist calcium carbonate, the excess being removed by filtration at the end of the reaction. The filtrate was treated with 95 per ct.

alcohol, which was free from acid, until the calcium caseinate was precipitated, after which the precipitate was washed with alcohol and ether, and dried at 120° C. A weighed portion of this compound was carefully ignited and the calcium in the resulting ash was determined, with the following results:

TABLE II.— AMOUNT OF Ca COMBINING WITH CASEIN WHEN REACTING WITH $CaCO_3$.

Weight of caseinate.	Weight of CaO.	Weight of Ca.	Weight of free casein.	CaO (and Ca) for 100 grams of casein.
Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*
0.4125	0.0102	0.0073	0.4052	2.52 (1.80 Ca)
0.5134	0.0124	0.0089	0.5045	2.46 (1.76 Ca)
0.3090	0.0077	0.0055	0.3035	2.54 (1.81 Ca)
0.4253	0.0104	0.0074	0.4179	2.49 (1.77 Ca)
Ave. 0.41505	0.010175	0.00726	0.4078	2.50 (1.78 Ca)

Preparation of basic calcium caseinate by treating casein with an excess of calcium hydroxide.— Weighed portions of casein were dissolved in an excess of lime-water. Phenolphthaleïn indicator was then added to the solution and hydrochloric acid was run in until the solution became neutral. The solution was then dialyzed to remove the calcium chloride formed in neutralization. The dialyzed solution was evaporated to dryness, the residue dried at 120° C. and weighed. The determination of calcium was made after ignition, with the following results:

TABLE III.— AMOUNT OF CALCIUM COMBINING WITH CASEIN ON TREATMENT WITH CALCIUM HYDROXIDE.

Weight of caseinate.	Weight of CaO.	Weight of Ca.	Weight of free casein.	CaO (and Ca) for 100 grams of casein.
Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*
1.582	0.040	0.0286	1.5534	2.58 (1.84 Ca)
1.471	0.035	0.0250	1.4460	2.42 (1.73 Ca)
1.548	0.038	0.0271	1 5209	2.50 (1.78 Ca)
Ave. 1.534	0.0377	0.0269	1.5070	2.50 (1.78 Ca)

The three sets of figures presented in Tables I, II, and III indicate that casein combines with calcium to form a compound containing about 2.50 per ct. CaO (equal to 1.78 per ct. Ca); the compound in

solution is neutral to phenolphthaleïn. Expressed in another form, 1 gram of casein combines with 9×10^{-4} gram equivalents of calcium. This compound is commonly known as *basic calcium caseinate.*

PREPARATION AND COMPOSITION OF UNSATURATED OR ACID CASEINATES.

Compounds of casein with bases, in which less base is present than in the basic calcium caseinate described above, have been reported. Söldner[1] obtained a compound of casein and calcium containing 1.11 per ct. Ca (equal to 1.55 per ct. CaO); or, expressed in another form, 1 gram of casein combines with 5.55×10^{-4} gram equivalents of calcium. This compound is neutral to litmus but acid to phenolphthaleïn, and has been commonly known as *neutral calcium caseinate.* This compound as prepared by Van Slyke and Hart[2] contains about 1.07 per ct. Ca (equal to about 1.50 per ct. CaO), or 1 gram of casein combines with 5.35×10^{-4} gram equivalents of calcium. Courant[3] believes that, in addition to the basic and neutral compounds of casein and calcium, a third exists, in which the calcium is present in about one-half the amount contained in the neutral compound and one-third that contained in the basic compound; he regards them as mono-, di- and tri-calcium caseinates. Timpe[4] reports a compound containing 0.961 per ct. Na (equal to 0.868 per ct. CaO or 0.62 per ct. Ca; or 1 gram of casein combines with 3.1×10^{-4} gram equivalents of calcium). Long[5] was able to dissolve 1 gram of casein in just one-half the amount of alkali required for the phenolphthaleïn neutralization, and therefore inferred the existence of acid caseinates containing one-half the amount of base contained in basic calcium caseinate. The existence of such a combination is questioned by Robertson.[6]

In the course of our work, we became convinced that casein forms compounds containing less base than any of those reported by other workers. While we were at work on this point, an article by Robertson[7] appeared, in which was reported a combination of casein and sodium hydroxide, 1 cc. of the alkali combining with 0.877 gram of casein. Our further work confirms Robertson's results, although we have used a different method of procedure. In addition, we have been able to prepare and isolate several salts for analysis. Our study of these individual salts shows that ammonium, sodium and potassium compounds possess properties of solubility very different from those of barium, calcium and strontium. As previously stated,

[1] *Landw. Versuchs.-Stat.*, 35: 351, 1888.
[2] N. Y. Agrl. Expt. Sta. Bull. No. 261, 1905.
[3] *Pflüger's Archiv. Physiol.*, 50: 109, 1891.
[4] *Arch. Hyg.* 18: 1, 1893.
[5] *Jour. Am. Chem. Soc.*, 28: 372, 1906.
[6] *Jour. Biol. Chem.*, 2: 336, 1906.
[7] *Jour. Physical Chem.*, 13: 469, 1909.

we have prepared and studied two sets of compounds of casein with bases, in one of which 1 gram of casein combines approximately with 1.125×10^{-4} gram equivalents of base, while in the other 1 gram of casein combines with about 2.25×10^{-4} gram equivalents of base.

We will next take up the details of our experimental work in preparing acid caseinates of the bases of the more common alkalis and alkaline earths.

The specific object of our work was to ascertain the smallest quantity of base with which casein combines to form a definite salt. In the volumetric work our method of procedure was as follows: In 200 cc. of $\frac{N}{40}$ alkali, we dissolved 5 grams of pure casein as quickly as possible and then made the volume to 250 cc. Each 50 cc. of this solution therefore represents 1 gram of casein dissolved in 50 cc. of $\frac{N}{50}$ alkali. A preliminary or trial determination was next made in the following manner: Into a 300 cc. Erlenmeyer flask, we measure 50 cc. of the caseinate solution and then add, a drop at a time, some $\frac{N}{50}$ HCl, until we have used 5 cc., the contents of the flask being kept in constant agitation in order to prevent premature precipitation of casein. After addition of the 5 cc. of acid, a portion of the contents of the flask is centrifuged, in order to cause the sedimentation of precipitated casein, if any, a precipitate serving as an indicator. A sedimentation tube of 50 cc. capacity can be used; the precipitate collects in the lower V-shaped portion. It is possible in this manner to detect the casein precipitated by 0.20 cc. of $\frac{N}{50}$ HCl. In case no casein is precipitated by the first addition of 5 cc. of acid, another equal amount of acid is added and a portion of the mixture centrifuged; the process of adding 5 cc. portions of acid and centrifuging is continued until a permanent precipitate of casein is obtained. This shows, within 5 cc. of $\frac{N}{50}$ HCl, how much acid is required to start definite precipitation of the casein. In order to ascertain the exact point more closely, another set of determinations is made, using 50 cc. of the caseinate solution and adding in the same cautious manner an amount of $\frac{N}{50}$ HCl which is 5 cc. less than the amount causing the first appearance of a permanent precipitate in the trial or preliminary determination. The acid is now added in small amounts with constant agitation of the mixture to prevent the premature separation of any precipitate, and centrifuged after the addition of each 0.25 cc. The point at which a permanent precipitate first appears is noted; the addition of acid is continued until all the casein is precipitated and this point is also noted. In our work this method of determination was repeated several times with each combination of casein and alkali and three different casein preparations were used in preparing each caseinate. We will now present the results of our experimental work in connection with the unsaturated or acid caseinates of, first, ammonium, sodium and potassium, and, second, barium, strontium and calcium.

Acid caseinates of ammonium, sodium and potassium.— In the manner described above, we made numerous determinations in the case of preparations of base-free casein dissolved in the hydroxide of ammonium, sodium and potassium, respectively. Tabulated below, we give the average results of many such determinations.:

TABLE IV.— RELATION OF ALKALI BASES TO CASEIN IN ACID CASEINATES.

Amount of casein used.	Kind of alkali used	Amount of $\frac{N}{50}$ alkali used.	Amount of $\frac{N}{50}$ HCl required to cause first sign of permanent precipitation.	Amount of alkali left combined with casein.		Amount of $\frac{N}{50}$ HCl required to precipitate all of the casein.
				$\frac{N}{50}$.	$\frac{N}{10}$.	
Gram.		*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*
1	NH_4OH	50	Between 44.25 and 44.50	5.5 to 5.75	1.1 to 1.15	50
1	Na OH	50	" " " "	" "	" "	50
1	K O H	50	" " " "	" "	" "	50

The results in this table indicate that 1 gram of casein forms a soluble compound with ammonium, sodium and potassium, when combined with amounts of each somewhere between 1.10×10^{-4} and 1.15×10^{-4} gram equivalents of alkali; or, expressed in another form, 1 cc. of $\frac{N}{10}$ alkali combines with an amount of casein somewhere between 0.87 and 0.91 gram. The proportion of basic element in each compound is approximately the following: NH_4, 0.20 per ct.; Na, 0.26 per ct.; and K, 0.44 per ct. Caseinates combining with the amount of alkali base indicated contain the smallest known amount of base, according to our present knowledge. It seems proper, therefore, to suggest that such compounds be called mono-basic caseinates.

Preparation of mono-ammonium caseinate.— It seemed desirable that we should carry the work somewhat farther and prepare one pure compound, at least, in dry form for study. The ammonium compound was chosen as the one offering least difficulty. The method of preparation was as follows: In 2 liters of distilled water containing 250 cc. of $\frac{N}{10}$ NH_4OH, 25 grams of base-free casein were dissolved. After solution was complete, we slowly added 125 cc. of $\frac{N}{10}$ HCl, care being taken to agitate the mixture during the addition of the acid, in order to prevent premature precipitation of any casein. There was next added very cautiously $\frac{N}{50}$ HCl until a permanent precipitate began to appear, as shown by centrifuging the mixture. The solution was then filtered and measured. The amount of $\frac{N}{50}$ HCl required to precipitate the casein completely was determined in an aliquot part. Then one-third of this amount was added to insure the presence of only mono-basic caseinate. Any precipitate formed was removed by filtration and the filtrate was dialyzed until the ammonium chloride that had been formed in the

reaction was completely removed. The resulting solution, containing mono-ammonium caseinate, was then precipitated by addition of acid-free alcohol. The precipitate was filtered, washed with acid-free alcohol and ether and dried at 120° C. In several preparations thus made the amount of ammonia was determined; the results are given in the following table:

TABLE V.— COMPOSITION OF MONO-AMMONIUM CASEINATE.

Amount of caseinate used.	Amount of $\frac{N}{10}$ NH_4OH found.	Relation of casein to NH_4OH in caseinate.	Percentage of NH_4 in caseinate.
Grams.	*Cc.*		
5.891	6.64	1 gram of casein to 1.127×10^{-4} grams equivalents	0.203
4.870	5.38	1 " " " 1.105×10^{-4} " "	0.200
*4.000	4.30	1 " " " 1.075×10^{-4} " "	0.194
*3.000	3.16	1 " " " 1.053×10^{-4} " "	0.190

* Preparations of caseinates made by Mr. O. B. Winter.

Acid caseinates of calcium, strontium and barium.— In making preparations of the caseinates of the alkaline earth bases, difficulty was experienced in obtaining concordant results. The trouble was finally found to be due to the presence of the chloride formed when the solution of the caseinate is treated with hydrochloric acid. Such chlorides tend to cause precipitation of the caseinates either by decreasing their solubility or, perhaps, by formation of double salts, consisting of the chloride in combination with the caseinate.[1] The difficulty of insolubility is readily overcome by removal of the chloride through simple dialysis before the amount is sufficient to cause precipitation. To accomplish this, we made use of the following process: In 200 cc. of $\frac{N}{40}$ hydroxide of calcium, strontium or barium, we dissolved 5 grams of casein and then diluted the solution to 250 cc. A preliminary or trial determination was made by adding $\frac{N}{50}$ HCl to 50 cc. of the caseinate solution in portions of 5 cc. at a time, agitating constantly and, after each addition, testing for the presence of a precipitate by centrifuging a portion, until a precipitate appeared, just as in the case of preparing alkaline caseinates (p. 319). Then to each of several flasks containing 50 cc. of the caseinate solution we added an amount of $\frac{N}{50}$ HCl that was 5 cc. less than the amount causing the first appearance of a permanent precipitate in the preliminary trial. The contents of the flask were then placed in dialyzing tubes and, by frequent changes of the surrounding water, most of the soluble chloride that had been formed was removed. The contents of one tube were then used for another

[1] Pfeiffer and Modelski, *Ztschr. Physiol. Chem.*, 81: 329, 1912.

preliminary test. An amount of acid less than that required to produce a precipitate in this second test was then added to all the tubes and the contents again dialyzed. This operation was continued in the manner indicated in the following table:

TABLE VI.— ILLUSTRATION OF METHOD USED IN PREPARING ACID CASEINATES OF CALCIUM, STRONTIUM AND BARIUM.

Amount of casein in solution.	Amount of $\frac{N}{50}$ hydroxide solution used.	Amount of $\frac{N}{50}$ HCl added.	Sign of precipitation.	
Gram. 1	*Cc.* 50	*Cc.* 30	Precip.	First trial.
1	50	25	0	Dialyzed and used for next.
1	50	30	0	" " " " "
1	50	35	Precip.	
1	50	25	0	Dialyzed and used for next.
1	50	30	0	" " " " "
1	50	35	0	
1	50	40	Precip.	
1	50	25	0	Dialyzed and used for next.
1	50	30	0	" " " " "
1	50	35	0	" " " " "
1	50	36	0	
1	50	37	0	
1	50	38	Precip.	
1	50	25	0	Dialyzed and used for next.
1	50	30	0	" " " " "
1	50	35	0	" " " " "
1	50	37	0	" " " " "
1	50	38	0	
1	50	39	Precip.	
1	50	25	0	Dialyzed and used for next.
1	50	30	0	" " " " "
1	50	35	0	" " " " "
1	50	37	0	" " " " "
1	50	38	0	" " " " "
1	50	38.5	0	
1	50	39	Precip.	

In the manner described above, we have made numerous preparations of calcium, strontium and barium caseinates; the averages of many results are given in Table VII.

We have found that in adding $\frac{N}{50}$ HCl to 50 cc. of a caseinate solution containing 1 gram of casein dissolved in 50 cc. of $\frac{N}{50}$ solution of hydroxide of calcium, strontium or barium, it requires less than

50 cc. of acid to precipitate the casein completely; the exact amount is 44.5 cc. of $\frac{N}{50}$ HCl. The remaining amount of base, equal to 5.5 cc. of $\frac{N}{50}$ hydroxide, or 1.1 cc. of $\frac{N}{10}$ hydroxide, appears to be held in combination in the insoluble compound.

TABLE VII.— CASEINATES OF CALCIUM, STRONTIUM AND BARIUM.

Amount of casein used.	Kind of hydroxide used.	Amount of $\frac{N}{50}$ hydroxide used.	Amount of $\frac{N}{50}$HCl required to cause first sign of permanent precipitate.	Amount of base combined with casein in solution.		Amount of $\frac{N}{50}$ HCl required to precipitate all casein.	Amount of base in precipitated casein.	
				$\frac{N}{50}$	$\frac{N}{10}$		$\frac{N}{50}$	$\frac{N}{10}$
Grams.		*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*
1	$Ca(OH)_2$	50	38.5 to 39	11 to 11.5	2.2 to 2.3	44.5	5.5	1.1
1	$Sr(OH)_2$	50	" " "	" " "	" " "	"	"	"
1	$Ba(OH)_2$	50	" " "	" " "	" " "	"	"	"

These results indicate the formation of two sets of compounds, when casein is dissolved in a hydroxide of calcium, strontium or barium and this solution is neutralized with acid under the conditions of our experiments. One set of compounds contains twice as much base as the other.

Attention is called to additional details in the following statements:

(1) In the di-basic compounds, as the results show, 1 gram of casein requires between 2.2×10^{-4} and 2.3×10^{-4} gram equivalents of hydroxide of calcium, strontium or barium to form a compound which is soluble in water when there is not present any, or more than a trace of, soluble chloride of any of these elements. The addition of even a small amount of a soluble salt of any of these elements to a solution of any of these di-basic caseinates causes the formation of a precipitate.

(2) In these di-basic compounds, 100 grams of casein combine (a) with 0.44 to 0.46 gram Ca (equal to 0.62 to 0.64 gram CaO), (b) with 0.96 to 1.01 gram Sr (equal to 1.14 to 1.19 grams SrO), or (c) with 1.51 to 1.58 grams Ba (equal to 1.69 to 1.76 grams BaO).

(3) Apparently, with the treatment described above, 1 gram of casein combines with about 1.1×10^{-4} gram equivalents of the hydroxide of calcium, strontium or barium to form an *insoluble* compound, when an acid is added in amount just sufficient to precipitate the casein completely. These compounds are regarded as *mono-basic.*

(4) In these insoluble mono-basic compounds 100 grams of casein combine approximately (a) with 0.22 gram Ca (equal to 0.31 gram CaO), (b) with 0.48 gram Sr (equal to 0.57 gram SrO), or (c) with 0.76 gram Ba (equal to 0.85 gram BaO).

(5) These insoluble compounds possess some highly interesting properties; they are soluble in a 5 per ct. solution of sodium, potas-

sium or ammonium chloride. This solubility is due to an exchange of bases, which, for our purpose, can be represented by the following reversible reaction:

$$\underset{\text{(insoluble)}}{Ca{<}{}^{\text{caseinate}}_{\text{caseinate}}} + 2\ NaCl \rightleftharpoons \underset{\text{(soluble)}}{2\ Na\ \text{caseinate} + CaCl_2}$$

That the reaction is a reversible one is supported by the following experimental evidence: Mono-calcium caseinate was prepared and freed from soluble calcium salts by washing and dialysis. The compound was then dissolved in a 5 per ct. solution of calcium-free sodium chloride. That an interchange of bases had taken place was shown by the fact that when the caseinate brine solution was dialyzed, calcium was found in the solution outside the dialyzing tube. This brine solution of caseinate was then dialyzed until free from calcium and was then filtered. A solution of calcium chloride was then added to this dialyzed solution and at once a precipitate of calcium caseinate was produced. That this precipitate is a calcium salt can be shown in two ways: (1) By washing and dialyzing until free from soluble chloride and then igniting. Calcium is found in the ash. (2) By washing and dialyzing until free from soluble calcium, then redissolving in 5 per ct. solution of calcium-free sodium chloride and dialyzing. Calcium is found to dialyze out of this brine solution of caseinate.

There is another point of interest in connection with this compound which we will briefly refer to here but consider in more detail in the report of another investigation. When a small amount of acid is added to milk or is formed in milk by lactic fermentation, a substance separates on warming which is very stringy and which easily dissolves in a 5 per ct. solution of sodium chloride. This substance is probably mono-calcium caseinate.

Preparation of mono- and di-calcium caseinates.— In order to study the composition and properties of these compounds more fully, preparations of mono- and di-calcium caseinates were made. The following method was employed: In 800 cc. of $\frac{N}{20}$ $Ca(OH)_2$ there were dissolved 20 grams of base-free casein. To this solution was added 400 cc. of $\frac{N}{20}$ HCl; the solution was then dialyzed to remove most of the resulting calcium chloride. Then $\frac{N}{20}$ HCl was added very cautiously under constant agitation of the mixture until a permanent precipitate began to appear, as shown by centrifuge. The solution was then dialyzed again and then more acid was added until a precipitate once more began to form. Alternate dialysis and addition of acid were continued until no more acid could be added without causing a precipitate. The amount of acid necessary to precipitate all of the casein was next determined in an aliquot portion, and one-third of this amount of acid was then added. The

precipitated casein was filtered out and the filtrate was dialyzed. This solution contained di-calcium caseinate. The solution was divided, one portion being used for the preparation of the di-calcium caseinate and the other for the mono-calcium caseinate.

In completing the preparation of the di-calcium caseinate, the salt was precipitated by addition of acid-free alcohol, the precipitate being washed with acid-free alcohol and ether, and then dried at 120° C. The composition of this preparation is given in Table IX.

In preparing the mono-calcium caseinate, the solution of di-calcium caseinate was treated with enough acid to precipitate three-fourths of the casein. The resulting precipitate was filtered, washed with water, acid-free alcohol and ether and then dried at 120° C. The results in Table VIII show the amount of calcium found in the preparation.

Table VIII.— Composition of Mono-Calcium Caseinate Preparation.

Amount of compound used.	Amount of CaO found.	Percentage of CaO in compound.	Relation of casein to calcium in compound.
Grams.	*Gram.*		
5	0.0149 (0.0106 Ca)	0.298 (0.213 Ca)	1 gram of casein to 1.06 x 10^{-4} gram equivalents.
5	0.0141 (0.0101 Ca)	0.282 (0.201 Ca)	1 gram of casein to 1.01 x 10^{-4} gram equivalents.
5	0.0146 (0.0104 Ca)	0.292 (0.209 Ca)	1 gram of casein to 1.04 x 10^{-4} gram equivalents.
Average...	0.01453 (0.0104 Ca)	0.291 (0.208 Ca)	1 gram of casein to 1.04 x 10^{-4} gram equivalents.

Table IX.— Composition of Di-Calcium Caseinate Preparation.

Amount of compound used.	Amount of CaO found.	Percentage of CaO in compound.	Relation of casein to calcium in compound.
Grams.	*Grams.*		
4.2825	0.0233 (0.0167 Ca)	0.544 (0.39 Ca)	1 gram of casein to 1.95 x 10^{-4} gram equivalents.
4.1215	0.0235 (0.0168 Ca)	0.572 (0.41 Ca)	1 gram of casein to 2.04 x 10^{-4} gram equivalents.
Ave. 4.202	0.0234 (0.01675 Ca)	0.558 (0.40 Ca)	1 gram of casein to 2.00 x 10^{-4} gram equivalents.

If we compare the results given in Tables VIII and IX with the figures given in paragraphs (1), (2), (3) and (4) on page 323, it is obvious that the results embodied in these tables are lower. The higher results are obtained by the volumetric method and are believed

to be nearer the truth, owing to the difficulty of preparing these caseinates in pure form. The values by the volumetric method are: 1 gram of casein to 1.10 (to 1.15) x 10^{-4} gram equivalents of calcium for the mono-basic caseinate, and 1 gram of casein to 2.2 (to 2.3) x 10^{-4} gram equivalents of calcium for the di-basic caseinate.

VALENCY OF CASEIN MOLECULE AND MOLECULAR WEIGHT OF CASEIN.

In the case of the compound of casein and calcium, which is neutral to phenolphthaleïn, it is found that 1 gram of casein combines with 9 x 10^{-4} gram equivalents of calcium. In the case of the mono-ammonium caseinate, the combination is in the proportion of 1 gram of casein to a value between 1.1 x 10^{-4} and 1.15 x 10^{-4} gram equivalents. Since we have one compound of known composition and another of approximately known composition, it should be possible by applying the rule of constant proportions to determine the true composition of the mono-basic caseinate and also the number of valencies satisfied in the caseinate neutral to phenolphthaleïn.

We have reason to believe that the proportion, 1 gram of casein to 1.125 x 10^{-4} gram equivalents of alkali, is the true value, since, first, this lies between the two limits (1.10 and 1.15) found in our volumetric work, and, second, this figure agrees with that found by assuming a valency of 8 for the basic calcium caseinate, in which 1 gram of casein combines with 9 x 10^{-4} gram equivalents of calcium. Thus, if the valencies satisfied are 8, the proportion becomes 1 gram of casein to 1.125 x 10^{-4} gram equivalents of alkali for mono-basic caseinates. If, however, we were to assume that the number of valencies in the basic compound is 7 rather than 8, then the mono-basic salt would, theoretically, have the composition, 1 gram of casein to 1.285 x 10^{-4} gram equivalents of alkali, a value too high for our analytical results. If, on the other hand, we were to assume the number of valencies in the basic compound to be 9, then the proportion in the mono-basic compound would become 1 gram of casein to 1 x 10^{-4} gram equivalents of alkali, a value too low for our analytical results obtained with mono-ammonium and other alkali caseinates. Assuming 8 as the true valency of basic calcium caseinate gives us the value, 1 gram of casein to 1.125 x 10^{-4} gram equivalents of alkali, a result which agrees with the volumetric results obtained in case of the mono-alkali caseinates.

If we use the sulphur content as a basis for calculating the molecular weight of casein we have $n(\frac{32.07}{0.72})\ 100 = n\,4454+$. Here the value of n appears to be 2, and the molecular weight would be 8908, which is in very close agreement with the value found above, 8888+. This would indicate that there are two atoms of sulphur in each molecule of casein.

The amount of phosphorus in casein was found to be 0.71 per ct., which would lead to the molecular weight, $n(\frac{31.04}{0.71})\ 100 = n4372-$. If the value of n is 2, the molecular weight of casein becomes 8744.

On the basis of 8 representing the true number of valencies satisfied in the basic-calcium caseinate molecule, the molecular weight of casein is $\frac{1}{1.125 \times 10^{-4}}$ or 8888+. Robertson[1] reaches similar results by deducing the molecular weight of casein in several different ways. This would also make the equivalent weight of casein equal to $\frac{8888}{8}$ or 1111. This value is in close agreement with the equivalent weight assigned by other workers to casein prepared from cow's milk. Laqueur and Sackur[2] give about 1135; Matthaiopoulos[3] gives 1131.5; Long[4] gives 1124.

As a result of the work here reported, it would seem possible, theoretically, to prepare a series of not less than eight combinations of casein with each of the basic elements studied.

According to what we have reason to believe at the present time, not less than four of these combinations have been prepared. Using the calcium compounds, we have the following series:

Name of compound.	Grams Ca for 100 grams of casein.	Valencies satisfied.
Mono-calcium caseinate	0.22 (equal to 0.31 CaO)	1
Di-calcium caseinate	0.44 (equal to 0.62 CaO)	2
Neutral calcium caseinate	1.07 (equal to 1.50 CaO)	5
Basic calcium caseinate	1.78 (equal to 2.50 CaO)	8

It is noticeable that in this series compounds are absent representing valencies of 3, 4, 6 and 7. Whether such compounds can be prepared no one can say at present.

PART II. PARACASEIN AND SOME OF ITS COMPOUNDS.

The term paracasein is generally applied to the precipitated protein compounds formed by treating milk with rennet-extract. The relations between casein and paracasein are not satisfactorily understood as yet. Little study has been given to the compounds formed by paracasein. Van Slyke and Hart[5] have shown that paracasein combines with calcium to form a compound neutral to phenolphthaleïn, containing about 2.40 per ct. CaO (1.71 per ct. Ca), or 1 gram of paracasein combines with 8.55×10^{-4} gram equivalents of calcium. They also found a compound neutral to litmus, in which there was about 1.50 per ct. CaO (1.07 per ct. Ca), or 1 gram of paracasein combines with 5.35×10^{-4} gram equivalents of calcium. According to their results, the compound containing the

[1] *Jour. Physical Chem.*, **15**: 179, 1911.
[2] *Hofmeister's Beiträge*, **3**: 193, 1902.
[3] *Ztsch. Analyt. Chem.*, **47**: 492, 1908.
[4] *Jour. Am. Chem. Soc.*, **28**: 372, 1906.
[5] N. Y. Agr. Exp. Sta. Bull. No. 261, and *Am. Chem. Jour.*, **33**: 472, 1905.

higher amount of calcium is soluble in water, while the other is insoluble. It will be later shown by us that both of these compounds are soluble in pure water. In reporting the compound neutral to litmus to be insoluble in water, the fact was overlooked that, under the conditions of their experiments, there was always present in the mixture a considerable amount of calcium chloride, which was formed by the reaction of the hydrochloric acid upon the lime-water solution of paracasein, and the presence of this calcium chloride caused the precipitation of the neutral calcium paracaseinate, as we shall show later.

We have been able to prepare compounds of paracasein corresponding to the mono- and di-basic caseinates, in which, however, the proportion by weight of paracasein to base is just one-half that found in the caseinates.

PREPARATION AND COMPOSITION OF ASH-FREE PARACASEIN.

Milk from which the fat has been removed as completely as possible by centrifugal force was heated to 37° C. and rennet-extract (Hansen's) was added in the proportion of 0.12 cc. per 1,000 cc. of milk. The milk was allowed to stand until the precipitated paracaseinate had separated as completely as possible. The resulting curd was then stirred vigorously in order to break it into small pieces and hasten the separation of the whey. When the curd had settled, the supernatant whey was removed by siphon. The paracaseinate was washed with distilled water several times, and finally 5 liters of water were added for each liter of milk originally used. Dilute ammonium hydroxide (6 cc. of strong reagent diluted to 1,000 cc.) was then added, as in the case of the preparation of casein (p. 314), and the mixture stirred until the paracaseinate was dissolved. The process of precipitating, washing and redissolving was continued as in the case of casein; the remaining calcium was finally separated by addition of ammonium oxalate and centrifuging. One preparation made in this way contained 0.07 per ct. of ash. One gram gave a clear solution when dissolved in 10 cc. of $\frac{N}{10}$ NH_4OH and 90 cc. of water. One preparation, with high ash content, gave the following results on analysis:

	Per ct.		Per ct.
Moisture	1.63	In dry substance:	
Ash	0.61	Nitrogen	15.80
In dry substance:		Phosphorus	0.83
Carbon	53.50	Sulphur	0.87
Hydrogen	7.26	Oxygen (by difference)	21.13

Another preparation with exceptionally low ash content gave the following results:

Ash....... 0.07 per ct. Phosphorus.... 0.71 per ct. Sulphur..... 0.72 per ct.

PREPARATION AND COMPOSITION OF BASIC CALCIUM PARACASEINATE.

Like casein, paracasein manifests its acid character by its power to liberate carbon dioxide from calcium carbonate, forming a calcium paracaseinate. The results of the reaction were measured by us in the same manner as in the case of casein (p. 316), and it is, therefore, not necessary to report any of the details of methods or results. The average of many determinations indicates that paracasein unites with calcium to form a paracaseinate which is neutral to phenolphthaleïn and has the same general composition; 1 gram of paracasein combines with 9×10^{-4} gram equivalents of calcium.

PREPARATION AND COMPOSITION OF UNSATURATED OR ACID PARACASEINATES.

In preparing acid paracaseinates of bases, the same volumetric method of procedure was followed as in case of the casein salts (p. 318). The appearance of a precipitate in a centrifuged portion after addition of acid to an alkali solution of paracaseinate was made to serve as an indicator in regard to the end point of the reaction. We dissolved 5 grams of the ash-free paracaseinate in 200 cc. of $\frac{N}{10}$ alkali, made up the solution to 250 cc. and then determined the end points by careful addition of $\frac{N}{50}$ HCl to 50 cc. portions.

Acid paracaseinates of ammonium, sodium and potassium.— In the manner described, determinations were made in the case of base-free paracasein dissolved in hydroxide of ammonium, sodium and potassium, with the results tabulated below:

TABLE X.—RELATION OF ALKALI BASES TO PARACASEIN IN ACID PARACASEINATES.

Amount of para-casein used.	Kind of alkali used.	Amount of $\frac{N}{50}$ alkali used.	Amount of $\frac{N}{50}$ HCl required to cause first sign of permanent precipitate.	Amount of alkali left combined with paracasein.		Amount of $\frac{N}{50}$ HCl required to precipitate all of paracasein.
				$\frac{N}{50}$	$\frac{N}{10}$	
Gram.		*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*
1	NH_4OH	50	Between 38.5 and 39	11 to 11.5	2.2 to 2.3	50
1	NaOH	50	" " " "	" "	" "	"
1	KOH	50	" " " "	" "	" "	"

These results show that 1 gram of paracasein combines with an amount of alkali somewhere between 2.2×10^{-4} and 2.3×10^{-4} gram equivalents, in forming soluble compounds with ammonium, sodium and potassium, which are acid to both litmus and phenolphthaleïn. Expressed in another form, 1 cc. of $\frac{N}{10}$ alkali combines with an amount of paracasein somewhere between 0.435 and 0.455 gram. The proportion of basic element in each compound is approximately as follows: NH_4, 0.40 per ct.; Na, 0.52 per ct.; K, 0.88 per ct. The amount of each basic element in these paracaseinates is just double that present in the corresponding casein compounds (p. 320).

The amount of acid required to precipitate completely the paracasein in these compounds is exactly equal to the alkali used to dissolve the paracasein; this indicates that there is no additional paracaseinate, in insoluble form, containing less of these basic elements.

Preparation of mono-ammonium paracaseinate.— This compound was isolated and prepared in dry form, for futher study, in the manner already described in the preparation of mono-ammonium caseinate (p. 320). Care must be taken to use a paracasein preparation free from casein or salts of calcium, strontium, barium, etc. A determination of the amount of ammonia present in preparations thus made is given below.

TABLE XI.— COMPOSITION OF MONO-AMMONIUM PARACASEINATE.

Amount of paracaseinate used.	Amount of $\frac{N}{10}$ NH_4OH found.	Relation of paracasein to NH_4OH in paracaseinate.	Percentage of NH_4 in paracaseinate.
Grams.	*Cc.*		
4	8.20	1 gram of paracasein to 2.05×10^{-4} gram equivalents	0.37
4	7.98	1 " " " 2.00×10^{-4} " "	0.36

These results show the difficulty of making a pure compound, but they indicate that the percentage of ammonium is double that found in the corresponding mono-ammonium caseinate.

Acid paracaseinates of calcium, strontium and barium.— In preparing paracasein salts of calcium, strontium and barium, the presence of their chlorides causes much more trouble in respect to precipitation than in case of the casein salts. Special care must be taken to prevent the accumulation of chlorides of these elements. By sufficiently frequent dialysis it was possible to obtain the results reported below (Table XIII). Another point in connection with paracasein is the fact of its slow rate of solution in the hydroxides of calcium, strontium and barium; on this account we used 400 cc. of $\frac{N}{40}$ hydroxide to dissolve 5 grams of paracasein, making the volume up to 500 cc. with water.

Trial or preliminary determinations were made in the same manner as with casein (p. 321), in order to determine the amount of $\frac{N}{50}$ HCl required to precipitate the paracasein in the absence of chlorides of calcium, strontium and barium. The specific details employed and results obtained are indicated in the following table:

TABLE XII.— ILLUSTRATION OF METHOD OF PREPARING ACID PARACASEINATES OF CALICUM, STRONTIUM AND BARIUM.

Amount of paracasein in solution.	Amount of $\frac{N}{50}$ hydroxide solution used.	Amount of $\frac{N}{50}$ HCl added.	Precipitation.	
Grams.	*Cc.*	*Cc.*		
1	100	80	Precip.	First trial.
1	100	75	0	Dialyzed and used for next.
1	100	80	Precip.	
1	100	75	0	Dialyzed and used for next.
1	100	76	0	" " " " "
1	100	77	Precip.	
1	100	75	0	Dialyzed and used for next.
1	100	76	0	" " " " "
1	100	76.5	0	" " " " "
1	100	77	Precip.	
1	100	75	0	Dialyzed and used for next.
1	100	76	0	" " " " "
1	100	76.5	0	" " " " "
1	100	77	0	" " " " "
1	100	77.5	Precip.	
1	100	75	0	Dialyzed and used for next.
1	100	76	0	" " " " "
1	100	76.5	0	" " " " "
1	100	77	0	" " " " "
1	100	77.25	0	" " " " "
1	100	77.50	Precip.	

The results obtained by the method of procedure indicated above are given in the following table for calcium, strontium and barium.

TABLE XIII.— PARACASEINATES OF CALCIUM, STRONTIUM AND BARIUM.

Amount of paracasein.	Kind of hydroxide.	Amount of $\frac{N}{50}$ hydroxide used.	Amount of $\frac{N}{50}$ HCl required to cause first sign of permanent precipitate.	Amount of base left combined with paracasein in solution.		Amount of $\frac{N}{50}$ HCl required to precipitate all paracasein.	Amount of base in precipitated paracasein.	
				$\frac{N}{50}$	$\frac{N}{10}$		$\frac{N}{50}$	$\frac{N}{10}$
Gram.		*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*
1	Ca $(OH)_2$	100	77.25 to 77.5	22.5 to 22.75	4.5 to 4.55	88.5	11.5	2.3
1	Sr $(OH)_2$	100	77.25 to 77.5	22.5 to 22.75	4.5 to 4.55	88.5	11.5	2.3
1	Ba $(OH)_2$	100	77.25 to 77.5	22.5 to 22.75	4.5 to 4.55	88.5	11.5	2.3

These results indicate the formation of two sets of compounds when paracasein is dissolved in a hydroxide of calcium, strontium or barium and this solution is neutralized with acid under the conditions of our experiments. One set of compounds contains twice as much base as the other, corresponding to the two sets of casein compounds. Additional details are discussed below:

(1) In the di-basic compounds, the results show that 1 gram of paracasein requires between 4.5×10^{-4} and 4.55×10^{-4} gram equivalents of hydroxide of calcium, strontium or barium to form a compound which is soluble in pure water. These compounds are easily precipitated from their water solutions by a minute amount of a soluble salt of calcium, strontium or barium.

(2) In these di-basic compounds, 100 grams of paracasein combine, approximately, (a) with 0.90 gram Ca (equal to 1.26 grams CaO), (b) with 1.97 grams Sr (equal to 2.33 grams SrO), or (c) with 3.09 grams Ba (equal to 3.45 grams BaO).

(3) It is indicated that, with the treatment described above, 1 gram of paracasein combines with about 2.3×10^{-4} gram equivalents of the hydroxide of calcium, strontium or barium to form an *insoluble* compound. These compounds are regarded as mono-basic paracaseinates.

(4) In these insoluble mono-basic paracaseinates, 100 grams of paracasein combine, approximately, (a) with 0.46 gram Ca (equal to 0.64 gram CaO), (b) with 1.01 grams Sr (equal to 1.19 grams SrO), or (c) with 1.58 grams Ba (equal to 1.76 grams BaO).

(5) Mono-basic paracaseinates of calcium, strontium and barium are completely soluble in warm 5 per ct. solution of ammonium, sodium or potassium chloride. This solubility is due to interchange of bases, just as in the case of caseinates (p. 18); the reaction was studied experimentally with paracaseinates and the same results obtained as in case of the caseinates.

(6) A comparison of the composition of the caseinates and paracaseinates shows that twice as much base is present in paracaseinates as in the corresponding caseinates. This is easily seen in the following table.

TABLE XIV.— COMPARISON OF COMPOSITION OF CASEINATES AND PARACASEINATES.

Amount of basic element combined with 100 grams of casein and paracasein.

Basic element.	In mono-basic caseinates.	In mono-basic paracaseinates.	In di-basic caseinates.	In di-basic paracaseinates.
	Gram.	*Grams.*	*Grams.*	*Grams.*
Ca.	0.22	0.46	0.44 to 0.46	0.90
Sr.	0.48	1.01	0.96 to 1.01	1.97
Ba.	0.76	1.58	1.51 to 1.58	3.09

Preparation of mono- and di-calcium paracaseinates.— In order to study the composition and properties of these compounds further, preparations of the mono- and di-calcium paracaseinates were made. The first steps in making these compounds are the same. An excess of ash-free paracasein is agitated with lime-water until a saturated solution is formed, the undissolved paracasein being removed by filtration. To the solution $\frac{N}{50}$ HCl is added until a permanent precipitate begins to appear. The solution is again filtered and then dialyzed. Alternate addition of acid and dialysis are continued until no more acid can be added after dialysis without causing precipitation. The amount of $\frac{N}{50}$ HCl required to precipitate all the paracasein is next determined in an aliquot portion, and one-third that amount of acid is added. The solution is then filtered and dialyzed. This solution contains di-calcium paracaseinate. This solution is divided into two portions; in one the di-calcium paracaseinate is precipitated by addition of acid-free alcohol, the precipitate being washed with acid-free alcohol and ether and dried at 120° C. This preparation was found to contain between 4.2×10^{-4} and 4.6×10^{-4} gram equivalents of calcium for 1 gram of paracasein.

In the second portion of di-calcium paracaseinate solution, enough $\frac{N}{50}$ HCl is very slowly added to precipitate three-fourths of the paracasein in solution. The precipitate is mono-calcium paracaseinate; this is filtered, washed with acid-free alcohol and ether, and dried at 120° C. Before being washed with alcohol, the precipitate is completely soluble in 5 per ct. solution of sodium chloride. This compound, mono-calcium paracaseinate, is identical in its properties with the brine-soluble compound formed in cheddar cheese, to which attention was first called by Van Slyke and Hart under the expression, "salt-soluble compound." Attention will again be called to this compound later. An analysis of this preparation showed it to contain between 2×10^{-4} and 2.3×10^{-4} gram equivalents of calcium for 1 gram of paracasein.

VALENCY OF PARACASEIN MOLECULE AND MOLECULAR WEIGHT OF PARACASEIN.

In the case of basic calcium paracaseinate, the compound that is neutral to phenolphthaleïn, it is found that 1 gram combines with 9×10^{-4} gram equivalents of calcium, while in the case of mono-ammonium paracaseinate the combination is in the ratio of 1 gram of paracasein to a value between 2.2×10^{-4} and 2.3×10^{-4} gram equivalents. According to the rule of constant proportions, the number of valencies satisfied in the first compound would be between $\frac{9}{2.2}$ and $\frac{9}{2.3}$ or 4. The molecular weight of paracasein would therefore be $\frac{1}{2.25 \times 10^{-4}}$ or 4444+. Our results indicate that the molecular weight of casein, 8888, is just twice that of paracasein 4444. Using the sulphur content as a basis for calculating the molecular weight of paracasein, we have $n(\frac{32.07}{0.72})\ 100 = n\ 4454+$.

The percentage of phosphorus would give $n(\frac{31.04}{0.71})\ 100 = n\ 4372$—. The value of n appears to be 1 and each molecule of paracasein would contain one atom each of sulphur and phosphorus.

Theoretically, it should be possible to make a series of four salts of paracasein with bases. We have prepared three, those in which one, two and four valencies are satisfied.

ACTION OF RENNET ENZYM ON CASEIN IN FORMING PARACASEIN.

The action of the principal enzym contained in rennet-extract in splitting casein into two molecules of paracasein is further shown by the following experiment: Five grams of casein are dissolved in 250 cc. of $\frac{N}{50}$ KOH. Using the volumetric method given on page 13, it was found that 44.5 cc. of $\frac{N}{50}$ HCl could be added to 50 cc. of the caseinate solution, containing 1 gram of casein, before a permanent precipitate begins to appear. To another 50 cc. of caseinate solution a few drops of neutral rennet-extract are added. Under the conditions of the experiment, no precipitate or curd is produced by the action of the rennet-enzym. After a few minutes $\frac{N}{50}$ HCl is added and it is found that a permanent precipitate begins to form as soon as we add only 39 cc. $\frac{N}{50}$ HCl.

We have in hand a more extended investigation relating to the action of rennet-enzym upon casein, the results of which will be published later.

PART III. COMPOSITION OF THE BRINE-SOLUBLE COMPOUND IN CHEESE.

During the manufacture and ripening of cheddar cheese and of many other kinds of cheese there is always found a protein that is soluble in a warm 5 per ct. solution of sodium chloride. The existence of such a substance in cheddar cheese was first brought to attention by work done at this Station.[1] The presence of this brine-soluble protein was shown to be associated in some way with the formation of acid in the cheese and, on the basis of some early experiments, Van Slyke and Hart were led to conclude erroneously that the substance consists of a combination of paracasein and lactic acid (called by them paracasein mono-lactate), which by the addition of more lactic acid becomes insoluble in dilute brine solution, forming a compound which they mistakenly regarded as paracasein di-lactate. As a result of later work[2] they changed their first views and came to the conclusion that the so-called paracasein mono-lactate is simply the uncombined protein, paracasein, and that the so-called paracasein di-lactate is a compound of paracasein and

[1] N. Y. Agr. Exp. Sta. Bul. No. 214, 1902.
[2] N. Y. Agr. Exp. Sta. Bul. No. 261, 1905.

lactic acid (1 gram of paracasein uniting supposedly with about 0.5 cc. $\frac{N}{10}$ acid). It may be stated here, in passing, that it was later shown by L. L. Van Slyke and D. D. Van Slyke[1] that the protein casein does not unite with acids to form insoluble compounds, but that the action is simply one of *adsorption*, by which more or less acid is taken from the surrounding solution and concentrated on the surface of the solid particles of protein; in other words, it was shown that casein or paracasein mono-lactate or di-lactate have no existence as applied to the compounds in question. It still remained, therefore, to find out what the brine-soluble substance really is, and work was continued along this line by the writers.[2] We noticed that calcium is always to be found associated with the brine-soluble substance when it is separated from the other cheese constituents by extraction with a solution of calcium-free sodium chloride after previous removal of all water-soluble constituents. This fact suggested the possibility that the brine-soluble substance might be a combination of paracasein and calcium, containing less calcium than had been previously found in any combination of this element with paracasein. On the basis of such a possibility, it could be explained that with the formation of increased amounts of lactic acid in cheese-making, as a result of the bacterial decomposition of milk-sugar, the acid would combine with more or less of the calcium contained in calcium paracaseinate, resulting in the production of a paracaseinate containing less calcium. This suggestion was strengthened by the fact that in Camembert cheese, the brine-soluble compound is formed during certain stages of the manufacturing process but soon disappears, its formation and disappearance being explained as follows according to Bosworth:[3] The brine-soluble substance is at first formed in Camembert cheese, as also in the case of cheddar cheese, but, owing to the method of making this type of cheese, more acid is allowed to form in the cheese, and, as a consequence, the brine-soluble substance loses its calcium and becomes free paracasein, which is insoluble in brine solution. Therefore, in the manufacture of Camembert cheese, it is found after the first few hours that the cheese contains no brine-soluble material and, what is also significant, all the calcium is found in the water extract. The relation between the brine-soluble substance and the calcium found in the brine extract in the two types of cheese is illustrated in Table XV.

The question necessarily suggests itself as to whether the calcium always found in the brine-soluble extract of cheese is not there incidentally in a mechanical state rather than in combination with paracasein. In order to study this question the following work

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[1] N Y. Agr Exp. Sta. Tech. Bul. No. 3, 1906.
[2] N. Y. Agr. Exp. Sta. Tech. Bul. No. 4, 1907.
[3] N. Y. Agr. Exp. Sta. Tech. Bul. No. 5, 1907.

TABLE XV.— COMPARISON OF CHANGES IN CHEDDAR AND CAMEMBERT CHEESE.

Age of cheese.	Kind of cheese.	Total nitrogen in the form of brine-soluble compound.	Total calcium found in brine-soluble compound.
		Per ct.	*Per ct.*
When curd was cut	Cheddar	3.13	trace.
	Camembert	6.72	trace.
10 hours	Cheddar	96.00	27.96
	Camembert	94.00	17.76
2 days	Cheddar	68.87	24.47
	Camembert	4.39	trace.
4 months	Cheddar	43.09	24.28

was done: Twenty-five grams of cheese were ground with sand and extracted with water at about 55° C., using 150 cc. portions, until the extract amounted to 1,000 cc. The residue, containing the brine-soluble substance, was placed in a dialyzing apparatus and allowed to dialyze to insure the removal of all soluble calcium. Sodium chloride was then added to the contents of the dialyzing tube, which was then placed in a beaker of water and allowed to remain 4 hours. Upon adding ammonium oxalate to some of the water in the beaker, a precipitate of calcium oxalate appeared. This result leads to the belief that the calcium is present in combination in an insoluble form and that an interchange takes place between it and sodium, when the insoluble compound is treated with sodium chloride solution.

In order to throw further light on the character of the brine-soluble compound, a study was made of the solvent effect of several different chlorides. One kilogram of cheddar cheese was ground fine, thoroughly mixed, and then 25-gram portions were ground with sand, placed in bottles and extracted with water in the manner described in the preceding paragraph. The residues were then extracted with solutions of chlorides and the results given in the following table were obtained. The solutions of the salts were used in such strength that 1,000 cc. contained equivalent gram molecules. In the case of the weakest solution, extraction was continued as long as appreciable amounts of protein were obtained in the extract, 4,000 cc. being used; the results in these cases are given for each 1,000 cc. of extract, as well as for the total.

In connection with the data in Table XVI, attention is called to certain phases of the results.

(1) The chlorides of barium and calcium have no solvent effect. The chloride of magnesium in strong molecular concentrations acts much like the chlorides of sodium, ammonium and potassium, while in lower molecular concentrations its solvent power is greatly reduced.

TABLE XVI.— SOLVENT ACTION OF NEUTRAL CHLORIDES ON THE BRINE-SOLUBLE COMPOUND IN CHEESE.

Strength of solution. Gram equivalents per 1,000.	Amount of extract.	Percentage of total nitrogen in water-insoluble residue of cheese extracted by —					
		Na Cl.	NH_4 Cl.	KCl.	Mg Cl_2	Ba Cl_2	Ca Cl_2
	Cc.						
1.0	1,000	68.57	67.62	50.47	63.81	0	0
0.8	1,000	69.29	65.24	50.47	48.33	0	0
0.6	1,000	56.19	56.43	45.95	lost	0	0
0.4	1,000	51.43	51.19	44.52	23.57	0	0
0.2	1st 1,000	47.62	49.05	40.95	4.00	0	0
0.2	2nd 1,000	13.33	10.48	13.90	5.24	0	0
0.2	3rd 1,000	2.95	4.10	2.00	4.29		
0.2	4th 1,000	trace	trace	trace	—		
Total	4,000	63.90	63.63	56.85	—		

(2) Sammis and Hart[1] undertook to study the solvent effect of these salts on the same material, but reached results not concordant with one another and not in agreement with ours. While we used solutions of such strength as to show the relation existing between the solvent action of the salt solution and its molecular concentration, they used solutions containing a uniform percentage by weight of different salts and extracted in every case with the same volume of solution. By using solutions of different salts having the same percentage composition by weight, but with a different molecular concentration, one would, under the circumstances, expect to obtain only discordant results, because the solvent effect of the solution is apparently a result of the mass action of the salt in solution (p. 324). If Sammis and Hart had in their work continued extraction until no more solvent effect was appreciable, their results would have been in satisfactory agreement with ours. This is strikingly shown in the above table in the case of the 0.2 normal solutions; by continued extraction, the total amounts extracted are found to be essentially the same as in case of the more concentrated solutions.

IDENTITY OF THE BRINE-SOLUBLE COMPOUND OF CHEESE WITH MONO-CALCIUM PARACASEINATE.

We have shown (p. 332) that paracasein combines with calcium to form a compound insoluble in water but soluble in 5 per ct. solution of sodium chloride (sodium replacing calcium). In this compound, we have shown, 1 gram of paracasein is in combination with

[1] *Jour. Biol. Chem.*, 6: 181, 1909.

2.25×10^{-4} gram equivalents of calcium. Indications pointed to the identity of the brine-soluble compound of cheese with this mono-calcium paracaseinate, and it remained to ascertain whether the protein part of the molecule in these two compounds is the same. In order to accomplish this, a preparation of the protein in the brine-soluble compound was made from cheese and its composition and properties were studied.

One kilogram of cheddar cheese was ground fine and then extracted with numerous portions of distilled water at about 55° C. in order to remove all soluble compounds. The residue was then extracted with many portions of a 5 per ct. solution of sodium chloride and filtered, first through absorbent cotton and then through paper. Dilute acetic acid was then added, giving a heavy precipitate, which was washed with water, redissolved in dilute ammonia and again precipitated with acid. The process was then completed as in the preparation of casein (p. 315). The preparation on analysis gave the following results, which are probably high, owing to the ash content:

	Per ct.		*Per ct.*
Moisture	2.32	In dry substance:	
Ash	0.25	Nitrogen	15.82
In dry substance:		Phosphorus	0.75
Carbon	52.97	Sulphur	0.78
Hydrogen	7.15	Oxygen (by difference)	22.28

A study of the properties of this substance resulted as follows:

(1) The substance acts as an acid in combining with bases.

(2) It decomposes calcium carbonate and gives a compound in which 100 grams of substance combines with the equivalent of 2.52 grams CaO (equal to 1.80 grams Ca), or 1 gram of substance combines with 9×10^{-4} gram equivalents of calcium.

(3) The solution of this calcium compound is neutral to phenolphthaleïn.

(4) Measured by the volumetric method, it was found to form a compound with ammonia represented by the combination of 1 gram of substance with 2.3×10^{-4} gram equivalents.

(5) With calcium it forms a compound soluble in 5 per ct. solution of sodium chloride but insoluble in water, which contains 1 gram of substance combined with 2.3×10^{-4} gram equivalents of calcium.

(6) It forms also a compound with calcium that is soluble in water, containing 1 gram of substance combined with 4.5×10^{-4} gram equivalents.

In view of the marked agreement of the composition and properties of the brine-soluble substance, formed in cheese, with the compound, mono-calcium paracaseinate, as prepared by us, there is good reason to believe that the brine-soluble substance is mono-calcium paracaseinate, having the composition of 1 gram of paracasein combined with 2.25×10^{-4} gram equivalents of calcium.

REPORT

OF THE

Department of Entomology.

P. J. PARROTT, *Entomologist.*

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REPORT OF THE DEPARTMENT OF ENTOMOLOGY.

THE PEAR THRIPS.*

P. J. PARROTT.

SUMMARY.

For several years pear blossoms in orchards in the Hudson River Valley have blighted, resulting in more or less extensive losses in fruit yields. Studies during the past spring have shown that the injury is caused by the pear thrips (*Euthrips pyri* Daniel), a new orchard pest, which has attracted considerable attention in recent years in California because of its destructiveness to various deciduous fruits.

The adult thrips, which is largely responsible for the injuries to the trees, is a small, darkish brown, winged insect measuring about one-twentieth of an inch in length. It appears in destructive numbers when the buds are opening, attacking the tenderest of the flower parts. The eggs are mostly deposited beneath the epidermis of the blossom and fruit stems. Hatching takes place within a few days, and the larvæ seek preferably the calyx cups, undersides of calyces, and the folds or under surfaces of the tender, expanding leaves. The larvæ feed for about two weeks and drop to the ground, in which they form a protecting cell. In this cell the insect completes its transformations and emerges from the ground in the spring as an adult. The thrips is single brooded; and the most active and destructive stages are coincident with the period that includes the life events of the swelling and opening of the buds and dropping of blossoms and calyces.

Injuries by the thrips in the Hudson Valley have apparently occurred over a period of five years. During the past three years fruitgrowers generally have noticed blighting of blossom clusters of pear trees, although the nature of the causal agent

* A reprint of Bulletin No. 343, January, 1912; for "Popular Edition," see p. 809.

seems not to have been suspected. According to statements of fruitgrowers the most severe attack of the thrips occurred during 1910, when the pear crop in many orchards was much reduced. Besides losses in yields the trees were seriously checked by injuries to leaf buds and leaf clusters; and in some orchards the season was much advanced before the trees presented normal conditions of growth. The productiveness of pear orchards during 1911 was greater than the preceding year, but blighting of blossom clusters was general and orchards suffered losses in yields according to the severity of the attacks by the thrips.

The actual range of distribution of the thrips in this State has not been determined. Its destructiveness to pear orchards has attracted the attention generally of growers about North Germantown, Germantown and Cheviot. Scattering numbers of this insect were found on pears growing south of this region, about Tivoli, to the north about Stuyvesant, and eastward to a line running between Chatham, Glencoe Mills and Clermont. It is reported also to occur across the Hudson River in orchards about Milton and Marlboro. The thrips is probably distributed over a larger territory in this valley than is indicated by these bounds. In western New York, specimens of this insect were found on apples growing about Geneva.

During 1911 the thrips was very abundant on apricots, apples, sour and sweet cherries, pears, peaches and plums about Germantown. The injurious work of the insect was most noticeable on pears, principally on the varieties Kieffer and Seckel. While sour and sweet cherries and apples were much infested by adult thrips, no material losses in the crops of these fruits were observed. The stems of sweet cherries are especially attractive to the adults for the deposition of the eggs, and they showed quite generally considerable scarification; but these injuries did not appear to cause any premature dropping of fruit or to affect the quality or yields. The work of the thrips in pear orchards was given chief attention, but future efforts will include the study of the thrips on other kinds of fruit.

The thrips is a difficult pest to combat because of the nature and suddenness of its attacks. Spraying is the most efficient method of control. The period for effective spraying is during the time when the buds are breaking and until they are entirely opened at the tips. The most promising spraying mixtures are the nicotine preparations in combination with kerosene emulsion or soap. Two or three applications on successive days during the past year largely prevented important injuries to pear trees. The physical features of the locations of the orchards, such as the direction and elevation of the slopes of the land, proximity to the Hudson River and character of the soil, have a marked influence on the development of the buds and the time of blossoming. The time for effective spraying will therefore vary with individual orchards.

NOTES ON THE INSECT.

DISCOVERY.

At farmers' institutes in the Hudson Valley during the spring of 1911, mention was frequently made of a peculiar blighting of pear blossoms which often resulted in a considerable loss of the crop. Chief interest in this trouble centered about Germantown, where certain fruitgrowers were alarmed at the unproductiveness of their orchards in spite of a promising showing of blossom buds for successive years. Judging from the sentiments of the orchardists and the knowledge that was available, the destruction of the blossoms could not be satisfactorily attributed to one of the more common insects or diseases that attack pears in this State. In order to determine the primary cause of the trouble, arrangements were made with Mr. A. W. Hover, an extensive fruitgrower at Germantown, to forward to this Station from time to time during April and early May pear buds in various stages of development. The shipments were made in a most satisfactory manner and on April 26 a bundle of pear wood was received by the Entomological Department which showed a few thrips crawling about the fruit spurs. In order that the insect should be correctly iden-

tified microscopic mounts were made of the specimens, which were sent to Dr. W. E. Hinds, of the Alabama Polytechnic Institute, who has made a special study of this group of insects. He identified the insect as the pear thrips (*Euthrips pyri* Daniel), a destructive fruit pest, not known heretofore to occur in the eastern states but which during recent years has attracted considerable attention among fruitgrowers in California.

ECONOMIC IMPORTANCE.

This insect has secured its reputation as a destructive pest from its ruinous attacks in recent years, commencing about 1904, on deciduous fruits in California. According to Foster and Jones the pear thrips is at present the most important insect in the region where it is established that growers of deciduous fruits have to combat. During the period of 1904 to 1910 the thrips, according to conservative estimates, caused losses in the Santa Clara Valley alone amounting to the value of nearly $2,000,000. The amount of damage done by the insect in this State during the past seven years has been computed[1] at seven millions of dollars. And this estimate does not take into account the money expended in spraying and other operations against the thrips.

In describing conditions in California, Moulton states that pears, prunes and cherries are most subject to injury, which he explains is due to the spreading of their buds at the time when the thrips are out in maximum numbers. Pears suffer mostly during the early development of the buds, and the blossoms are nearly all dead, at times of destructive outbreaks, before the clusters open. The fruits that set may be ill-shaped and badly scabbed. The attacks of the thrips on cherries and prunes are similarly destructive. The adult insect attacks the developing buds which checks the natural growth, and blossom clusters most seriously affected eventually fall. The deposition of eggs in the fruit stems weakens the stems, causing the young fruit to drop.

[1] Cal. Hort. Com., Monthly Bul. 1:52. (1912.)

The quality of prunes that mature may also be impaired by the feeding of the larvæ on the skin of the fruit causing a diseased condition known as "scab." The Napoleon Bigarreau and Black Tartarian cherries and Imperial prune are among the varieties known to New York fruitgrowers, that are attacked by the thrips. Almonds, apricots and peaches, while also subject to injuries, do not usually sustain such serious losses unless the thrips are very numerous.

DESCRIPTION, LIFE HISTORY AND SEASONAL NOTES.

Adult.—The adult, which is the most destructive stage of the species, is a dark-brownish, four-winged insect about one-twentieth of an inch long. The wings are long and narrow and are delicately fringed with long hairs; when at rest they lie horizontally along the back and are then very inconspicuous, thus often deceiving one momentarily as to the nature and range of the activities of the insect. On account of the structure of the wings these insects used to be designated "fringe-wings" (See Fig. 1), but now they are more often popularly called "thrips," which is a Latin name derived from the Greek θρὶψ, meaning a wood louse. The species attacking pears is known as the "pear thrips" because it was first discovered in pear blossoms to which it proved to be very destructive, although it has since been shown that other fruits suffer equally from its injurious work. The mouth parts of the thrips are largely suctorial in function, and consist of a broad, cone-like structure projecting from the underside of the head. The apex of this organ is quite sharp and of a horny nature, adapted to lacerating soft vegetable tissues. In feeding, the thrips punctures and rasps tender flower and leaf structures, setting free the plant juices, which are sucked up into the alimentary canal. This feeding may cause much damage to fruit trees. The insects seek preferably the rudimentary flower and leaf parts in the partially opened buds, but when the buds are more fully developed they feed more or less openly on the stamens, pistils, petals, tender leaves and apparently on the secretions from the nectaries

in the center of the blossoms. If the thrips are numerous the injured buds of pear trees become sticky with a brownish liquid and cease to develop, while the blossom clusters have a stunted, shriveled and brownish appearance as if blasted. With slight jarring the bud scales fall to the ground in unusually large numbers, while the dead blossom clusters usually adhere longer and slough off gradually. In clusters only partially injured the petals may be small and uneven in size, the stems dwarfed and of irregular lengths, and the calyces and other structures of the blossoms more or less blackish or brownish. The leaves of the first-formed clusters are generally dwarfed in size, crinkly or cup-shaped or otherwise deformed, with the margins irregularly broken and blackened. These deformations are more or less in evidence on the trees throughout the summer. The fruit setting on such clusters generally has weak stems and falls prematurely. However, some trees under circumstances not wholly understood may have the appearance of being severely injured and withal show a fair setting of pears. The effects of the attacks of the thrips on fruit yields depend on the numbers of blossom buds destroyed. During the past season some trees on account of the severity of the attack produced little or nothing, while on adjoining trees the work of the thrips was not so extensive, being confined largely to individual branches or portions of the trees, causing a very uneven setting of the fruit.

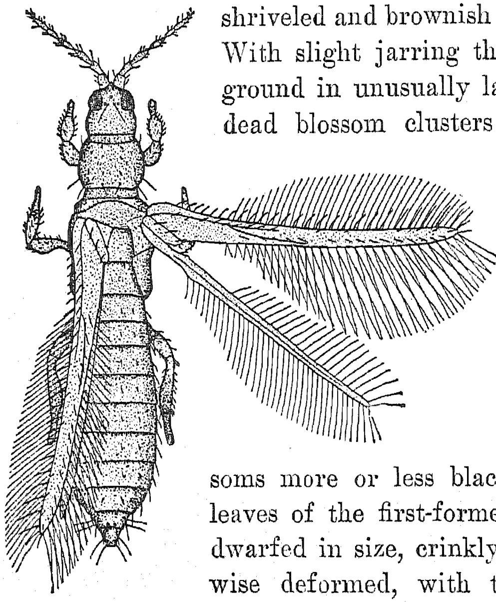

Fig. 1.—Pear Thrips: Adult. (Much enlarged)

On cherries the adults injure the stems of the fruit during the act of oviposition and they also produce discolored areas and holes

in the foliage, as described in detail for the larvæ. Deposition of eggs is most active during the period which includes the opening of the buds, blossoming and the dropping of blossoms and calyces, but oviposition probably occurs throughout the life of the adult although somewhat intermittently during its latter days.

While the thrips are winged and are capable of sustained flight, no concerted aerial excursions by any appreciable numbers of the insects were observed. In walking beneath the trees an occasional thrips dropped on the note-book and a few specimens were caught on sheets of sticky fly-paper purposely placed to detect their movements. Throughout their attacks on pears the thrips seemed to remain close to the trees, passing from one bud to another by creeping as the blossom and leaf clusters reached the desirable stages of development. According to Moulton[1] injuries to trees may be so severe that they no longer afford suitable food, when the thrips may migrate to other less affected orchards. According to him migration occurs during warm, clear weather, and the thrips distribute themselves generally wherever conditions are favorable for their sustenance and propagation.

Egg.— The egg (Fig. 2) is a microscopic, whitish and somewhat elongated object which may be compared to a bean or kidney in shape. The eggs are deposited in largest numbers in the stems of blossoms and leaves. The female thrips is equipped with a stout, curved, saw-like ovipositor and by means of this organ slits are cut in the tissues of the plant for the reception of the eggs. The incision is small but oviposition is frequently so extensive, especially in sweet cherries, that the stems show plainly the effects of the wounds. During the past season these injuries did not appear to have any appreciable influence on either the quality or yield of fruit, but according to Moulton so many incisions may be cut into a single stem that it will weaken and turn yellow and the young fruit fall

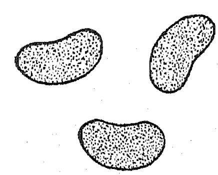

Fig. 2.—Pear Thrips: Eggs.
(Much enlarged)

[1] U. S. Dept. Agr., Bur. Ent. Bul. No. 80, p. 57.

prematurely. The injury to prunes and cherries in California through the deposition of eggs is at times very noticeable and is apparently the cause of considerable dropping of fruit. The incubation of the egg is of short duration and hatching occurs within a week after oviposition.

Larva.—The larva is a small, white, soft-bodied creature with a single pair of eyes, and its shape and the character of its external structures are represented in Fig. 3. The larvæ may be detected about the time of blossoming when they emerge from blossom and leaf stems, and later from the surfaces of the young fruits. When Kieffer pears were commencing to bloom the larvæ were observed in considerable numbers pushing their way up through slits made in the plant tissues for the reception of the eggs. Their presence was plainly indicated by the pimpling of the stems and young fruits and by the appearance of tiny whitish objects of indefinite shape, rendered conspicuous by two reddish spots which proved to be the eyes of the newly hatched insects. By struggling and swaying their bodies the young thrips gradually release their appendages and emerge from the nidi of the eggs as fragile, mite-like creatures. The time consumed for the entire process from the extrusion of its head to the release of the larva from the egg shell is variable but with some individuals it occupied as much as thirty to forty minutes. Upon their release the larvæ seek the calyx basins or the axils and rolled margins of the leaves where they may be quite readily seen by a careful, observing orchardist.

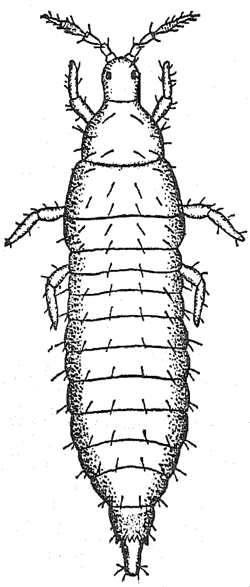

FIG. 3.—PEAR THRIPS: LARVA.
(Much enlarged)

The larva has mouth-parts similar in structure and function to those of the mature insect, and it feeds in like manner. Com-

pared with the winged thrips it is less active and less destructive on the whole to the trees, but it is nevertheless capable of causing quite a little damage under certain conditions. On pears the principal injuries by the larvæ are to the young leaves. The production of the young is unfortunately most abundant on those trees which suffer the most from the adult thrips because oviposition largely accompanies feeding at the time when the trees are most severely injured. The destruction of a considerable percentage of blossom and leaf buds by the adults is a great shock to the tree, and because of its weakened state it is usually slow in recovering its normal conditions of foliage. The new growth from the weak leaf clusters and the adventitious buds is likely to be feeble and small in quantity, and not infrequently young leaves in the opening buds or before they have unrolled are killed by the young thrips, or are so injured that on expanding they are stunted and ill-shapen. This accumulated injury by the larvæ further retards the recuperation of the tree and may result in premature dropping of the young pears or in the death of fruit spurs. With the dropping of the petals the calyx basins of the fruits become less and less attractive to the larvæ and eventually most of them find their way to the foliage. The folds or rolled edges of unfolding leaves, particularly of the terminal growth, are especially sought by them. Globules of sap accumulate from wounds as a result of the feeding punctures and the young leaves become blackened along the margins and cup-shaped or otherwise distorted in appearance. On cherries, especially of the sweet varieties, the larvæ collect in large numbers under loosened calyces of the young fruits and cause abrasions in the surface of the skin. During the past season these injuries were superficial and did not appreciably affect the appearance of the fruit. The larvæ also feed on the foliage and seem to prefer to work on the under surfaces of the leaves, principally along the main rib or in the angles formed by the secondary veins. Light-colored blotches with brownish centers develop which become quite conspicuous at the time the calyces are dropping, for hardly a leaf

is unaffected. These wounded areas later form holes and the leaves become much perforated and quite ragged in appearance. The larvæ attack plum leaves and fruit in a similar manner. After feeding for about two weeks the larvæ begin to drop from the foliage, when they may be found on weeds beneath the trees. From these they obtain subsistence for a short period when they enter the ground and form resting cells in which to complete their transformations,— in the autumn to pupæ, and later in the season to adults.

Seasonal history.— In the spring the adults emerge from the ground and seek the trees which afford attractive conditions for subsistence and the deposition of eggs. Selecting the buds that are beginning to open at the tips, the winged thrips work their way within and attack the tender flower and leaf parts. The date when the mature insects first appeared on the trees this spring was not obtained, but a few specimens were observed on April 26. They seemed to be most numerous and destructive from April 28 through the first week in May. With the falling of the petals from May 11 to May 14 the adults became less numerous on pear trees, and practically disappeared from plantings of this fruit by the latter part of the month. Oviposition was most active during the last few days of April and up to the middle of May. The first young thrips was detected on May 9, and on succeeding days larvæ emerged in large numbers, being very conspicuous in the calyx basins of the fruit following blossoming. The latest date of emergence of larvæ was May 25. The young thrips commenced to drop to the ground beneath the trees on May 17, when several of them were caught on sheets of sticky fly-paper. Plants under the trees were then examined and many larvæ were found on leaves of burdock, bitter-sweet, chick-weed, dandelion and wild rose. Quite a few individuals were entrapped in spider webs. Siftings of the earth during the summer and fall revealed no changes in the conditions of the larvæ until October 13, when the first pupa was found. The first adult to be found in an earthen cell was obtained on November 29.

DISTRIBUTION.

The pear thrips occurs in the region about San Francisco Bay, California. It has also been reported by Bagnall[1] to occur in England. This bulletin calls attention to the discovery of this pest in New York, which it is of interest to note is the only region in the United States outside of the heretofore recognized area of infestation where the thrips is known to exist.

The actual range of distribution of this insect in this State has not been ascertained. Its destructiveness to pear orchards has attracted the attention generally of pear growers about North Germantown, Germantown and Cheviot. Scattering numbers of the insect have been observed on pears grown south of this region, about Tivoli, to the north about Stuyvesant, and eastward to a line running between Chatham, Glencoe Mills and Clermont. Some growers who have read descriptions of the work of this insect state that it also occurs across the Hudson River in orchards about Milton and Marlboro. It is not improbable that the thrips occurs over a larger area in this valley than is indicated by these bounds. Fig. 4.

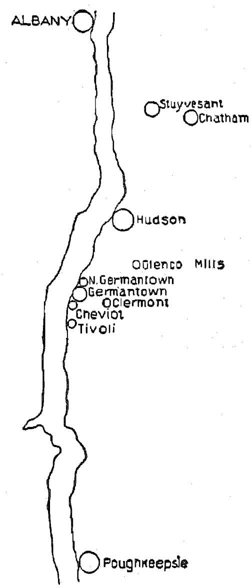

Fig. 4.— Known Distribution of Pear Thrips in the Hudson Valley.

On April 26 specimens of thrips were found at Geneva in apple buds, which plainly showed evidences of injury. While the season was too far advanced to find adults, many pear orchards were examined during May and June in Oswego, Wayne, Monroe, Orleans, Niagara and Erie counties for evidences of the thrips' work on blossom clusters and leaves, but without success. Its distribution in the State is a matter for future inquiry.

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[1] *Jour. Econ. Biol.* 4: 37.

FOOD PLANTS.

In California the thrips attacks deciduous fruits, including almond, apple, apricot, cherry, fig, grape, peach, pear, plum and prune and the English walnut. In England it has been found in wild plum blossoms. During the past year the thrips was observed in New York chiefly on apples, apricots, cherries, peaches, pears, plums and quinces.

LITERATURE.

The literature dealing with this species is not extensive as it has only in recent years come to be seriously considered by both systematic and economic workers. The insect was first described in 1904 by Miss S. M. Daniel in *Entomological News*,[1] from specimens obtained from pear blossoms in the vicinity of San Leandro, California. In 1905 a circular entitled "The Pear Thrips" by Dudley Moulton was issued by the California State Commission of Horticulture which called the attention of the fruitgrowers of that State to the destructiveness of this new pest to the deciduous fruits. This author has continued his investigations on the life history and habits of the pear thrips and methods of control which are discussed with considerable detail in bulletins of the United States Department of Agriculture.[2] A circular by S. W. Foster and P. R. Jones[3] of the same Bureau is more popular in its nature and is a most serviceable publication for the orchardist. It holds out encouragement to fruitgrowers for the control of the thrips by efficient spraying.

PEAR THRIPS AT GERMANTOWN.

EXPERIENCE OF FRUITGROWERS.

The occurrence and discovery of the pest for the first time in a region so remote from its heretofore known range of distribution in the United States constitute in themselves interesting facts. The questions now arise how long has the thrips been established in the Hudson River Valley and what is its importance to the

[1] *Ent. News*, **15**: 294.
[2] U. S. Dept. Agr., Ent. Buls. 68, pt. 1, and 80, pt. 4.
[3] U. S. Dept. Agr., Ent. Circ. 131.

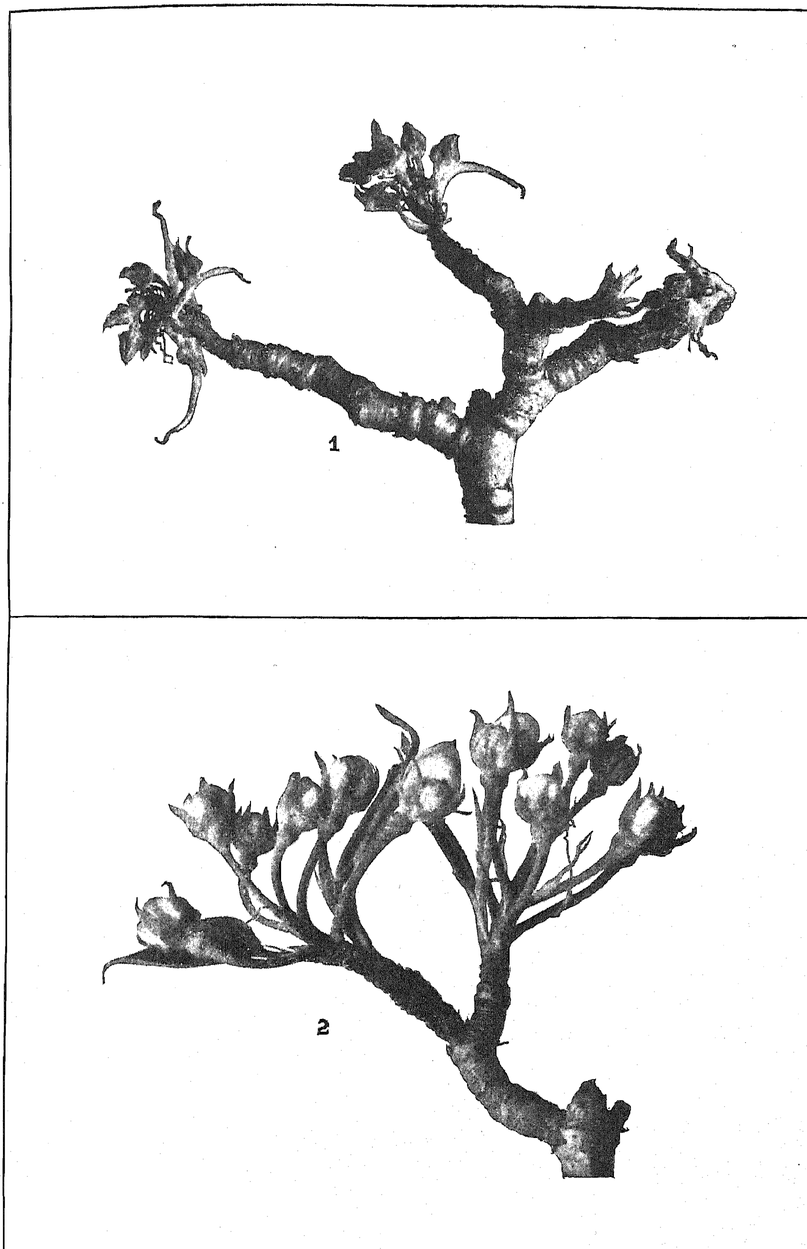


PLATE XXX.—KIEFFER PEARS BEFORE BLOSSOMING: (1) BLOSSOM-CLUSTERS INJURED BY THRIPS; (2) UNINJURED BLOSSOM-CLUSTERS OF SAME AGE.

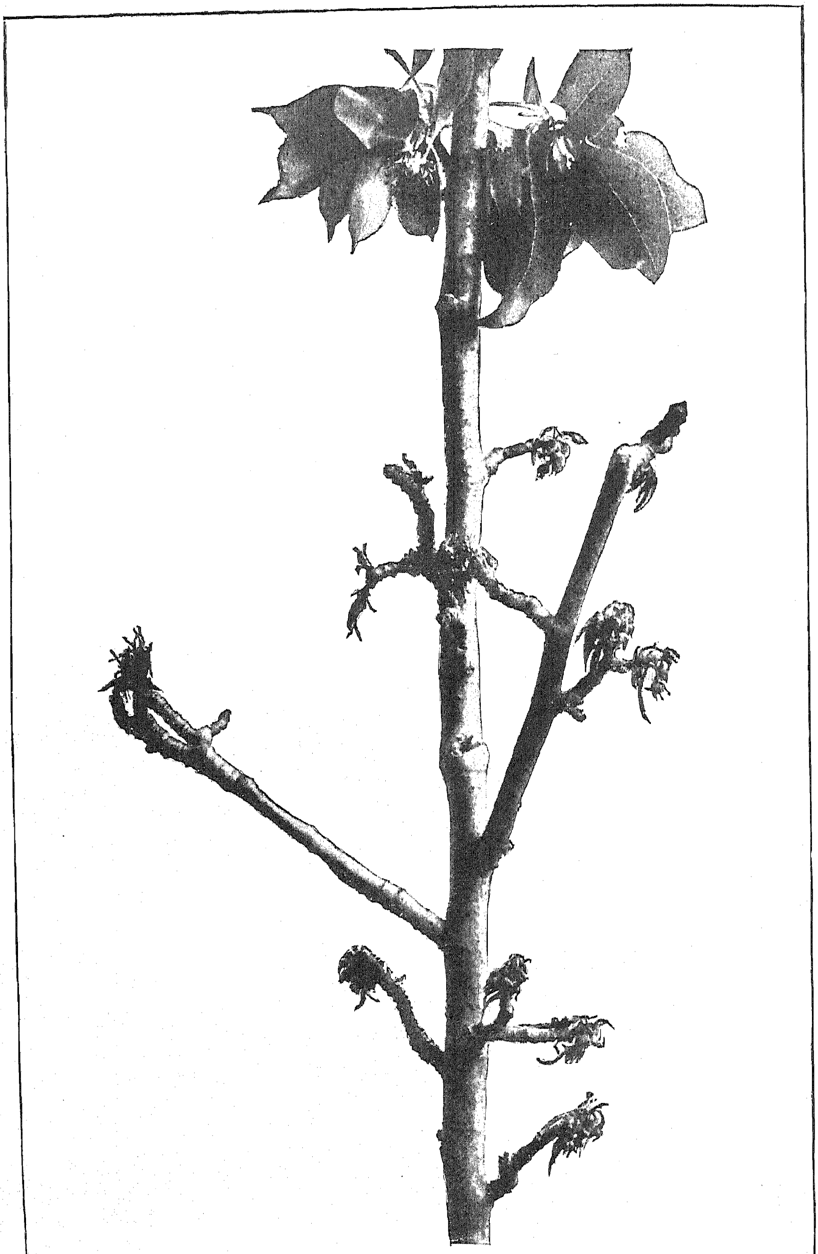


PLATE XXXI.—KIEFFER BRANCH SHOWING "BLIGHTING" OF BLOSSOM-CLUSTERS DUE TO WORK OF THE THRIPS.

Plate XXXII.—Kieffer Branch Showing "Sloughing-off" of Blossom-Clusters, and Young Leaf-Clusters Injured by Thrips Larvæ.

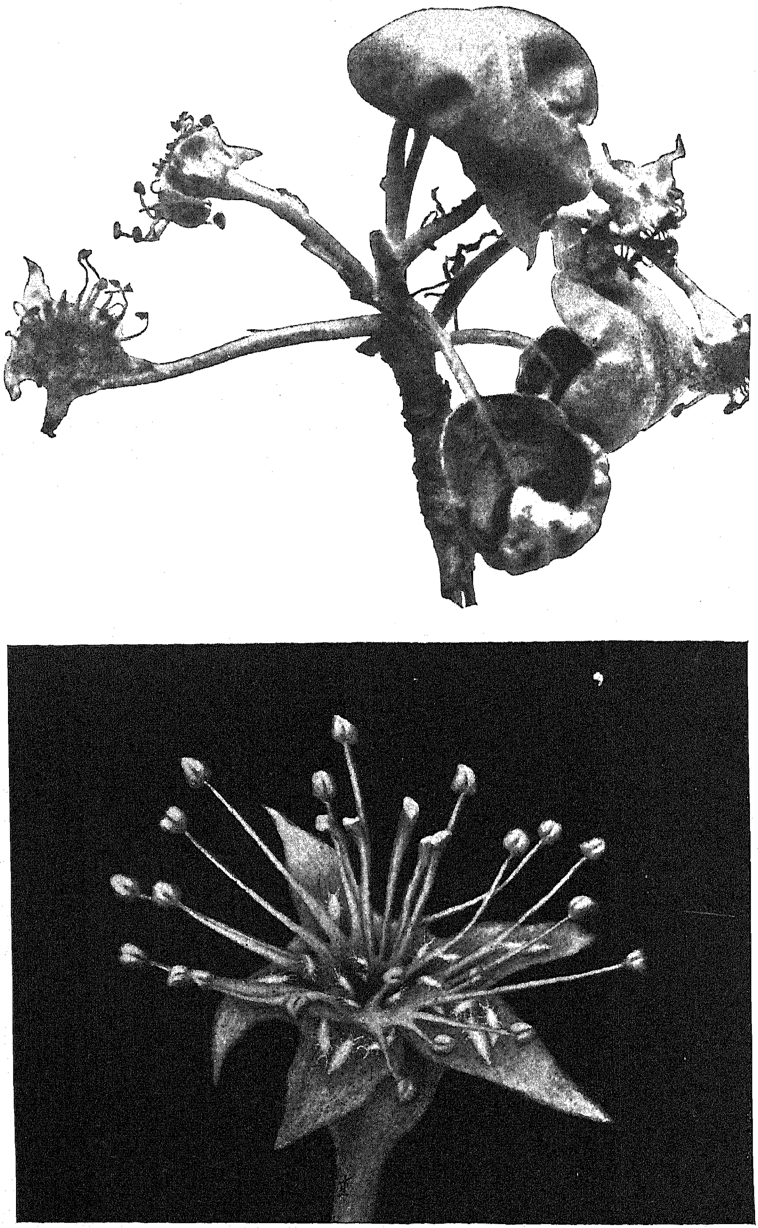


PLATE XXXIII.—APPLE BLOSSOM-CLUSTER INJURED BY THRIPS AND YOUNG PEAR SHOWING THRIPS LARVÆ IN CALYX BASIN.

fruit interests. The experiences of fruitgrowers with this insect affords some light on these questions. The following statements obtained by personal interview with individual growers are but a few secured reporting the occurrence of this pest in their orchards. Those chosen for publication bring out some special phases of the subject: as length of time the thrips has been destructive in the community, nature and extent of injuries, varieties of fruit affected; in short, such notes as will in any way afford light on the occurrence and behavior of the thrips in their respective plantings.

Edmund Bunk, Germantown.— Kieffer blossoms and some leaves turn brown about the time of blossoming, and believed the trouble was due to frost. First saw the blighting in 1910.

M. M. Rivenburgh, Germantown.— Seckels have always been the most injured and during the past five years have had only one fair crop. Should have from 75 to 100 barrels of fruit, but since this pest appeared have harvested only about 10 barrels each year. In 1910 the crop was only 2 barrels. Kieffers have suffered losses next in importance to the Seckels, running from one-third to two-thirds of a crop on many trees, the injury increasing each year until this year. The injuries to Bartletts and Clapp Favorites have only been slight as yet. About the time of blossoming the trees most severely attacked turn brown. Have always thought that the injury was due to frost or to use of spraying mixtures.

Peter Fingar, North Germantown.— In 1910 Kieffers turned brown as if burned; the leaves fell and later the fruits so that the trees looked as if in winter. My loss was probably one-half of the crop. Later on the leaves came out but the trees did not produce many fruit buds and thus shortened the crop for this year. Same injuries to a less extent on Clapp Favorites and Bartletts. Heard of the same trouble on Seckels over three years ago.

Roy Lasher, Germantown.— Have had good crops of Kieffers until 1910 when the yield was practically a failure. About blossoming time trees appeared as if they were blighted. Leaves and blossoms dropped and later a new crop of leaves appeared. The unfavorable conditions of the trees were generally attributed to frosts or spraying mixtures.

Clarence Snyder, North Germantown.— Blossom and leaf clusters turned brown about blossoming time in 1910, causing a loss of over half the crop. Some trees were late in getting another crop of leaves. Principal injuries are to Kieffers, and the trees most seriously affected in 1910 show this year little or no fruit and less than the normal amount of foliage.

C. A. Lasher, Germantown.— First noticed injuries to blossom buds in 1910 when varieties such as Seckel, Bartlett, Beurre Bosc, Vermont Beauty and Dana Hovey were attacked. The pest was most destructive to Seckels and caused a loss of over two-thirds of the crop.

Webster Coons, Germantown.— Injuries were first noticed on Kieffers last year when the trees at time of blossoming had the appearance of being swept by fire. The loss was about two-thirds of a crop.

CLYDE LASHER, North Germantown.— First noticed the work of the thrips during the spring of 1911, especially on Bartletts which are much affected. Injuries are less on Kieffers, Clapp Favorites and Seckels.

B. C. SNYDER, North Germantown.— First noticed the work of the thrips during 1910 in spots in my pear orchard, the Kieffers being most affected. This year it has also appeared on Seckels. My losses from this pest have not been so great as those of other pear growers.

SAMUEL SHEFFER, Germantown.— For the last three years I have practically had no crops from my pears. In 1910 I had 220 barrels when I should have had not less than 1,000 barrels. Had thought my losses were due to frosts. While there was much evidence of the thrips' work this spring, my trees yielded better this year.

GARFIELD MOORE, Germantown.—Injuries are most conspicuous on Kieffers and in 1910 lost practically the entire crop. Clapp Favorites also have shown losses in blossom clusters.

C. E. HOVER, Germantown.— For five years preceding 1911 have not harvested a satisfactory Kieffer crop and one orchard has yielded absolutely nothing during this period. Trees may blossom but I do not get any pears. The blossom clusters and leaves turn brown and gummy and drop. Clapp Favorites do not seem to be injured to the same degree and Bartletts suffer apparently the least from this pest. I believe the thrips is distributed throughout this region in a radius of about ten miles, although it is not equally destructive in all orchards.

ALEX. HOVER & BRO., Germantown.— Our Kieffers in one orchard have been blighted for three years. The greatest damage was in 1910 when blossoms and leaves turned brown and dropped; and there was practically no fruit worth picking. Bartletts and Clapp Favorites have as a rule not been much affected.

BERNES VAN TASSEL, North Germantown.— Have observed injuries to pear trees for three years, but the trees suffered the most during 1910. My Seckels had greater losses than any other variety, and it was not till late summer that the trees had a satisfactory amount of foliage.

The foregoing statements show that the thrips has been present in some orchards about Germantown for about five years and during the past three years it has become injurious to such a degree that its work is generally recognized throughout the community. It is of interest also to note that the growers without exception complain of losses to pears, but the attacks of the thrips on other fruits receive no comment. Injuries to Kieffer pears are reported by many orchardists and the yields of this fruit seem to have been most affected, especially during 1910. The financial loss with some growers was large because of the susceptibility of this variety and the extensiveness of the plantings. Kieffers are grown in larger numbers than any other pear. Some growers

even assert that the plantings exceed those of all other varieties combined.

Because of the increasing destructiveness of the thrips during recent years, the opinion quite generally prevails that the introduction of the pest in this community is of recent origin. However, there are no data on which to base any statement, and the circumstances of its introduction and early history are conjectural. The thrips has undoubtedly been longer established than has been indicated, and the outbreaks during the past few years, culminating in the destructive attacks of 1910, were probably induced by predisposing conditions arising chiefly from severe and prolonged droughts for successive summers and the abnormally early development of fruit buds during that year.[1]

OUTBREAK OF THE THRIPS DURING 1911.

The thrips was first observed on April 25 when a few specimens were captured on pear trees. On April 28 the insects were generally more abundant and they were seen in varying numbers on apricots, apples, sour and sweet cherries, pears and plums. Especially noticeable was the relatively greater abundance of the thrips on Kieffer pears, and it appeared that the advanced growth of the buds in orchards on warm and protected slopes made the trees of this variety more attractive than other fruits in somewhat different situations. During the next few days the thrips swarmed about the Kieffer buds which, while still compact, were now projecting beyond the bud scales. From the trees there exuded a clear or brownish liquid while blossom clusters as yet not expanded

[1] The spring of 1910 was early and sudden. No records are available showing the dates of blooming of pears at Germantown, but the season is generally regarded to be from ten to fourteen days in advance of conditions at Geneva. The dates for blooming of Seckel (a variety much subject to injury by the thrips) at Geneva from 1904 to 1911 is as follows:

1904	May 14 to May 17.
1905	No bloom.
1906	May 4 to May 18.
1907	May 16 to May 22.
1908	May 17 to May 21.
1909	May 14 to May 17.
1910	*April 25* to *May 2.*
1911	May 10 to May 13.

were beginning to turn brownish or blackish. On May 1st the destructive effects of the thrips' work seemed to be the most conspicuous. The trees most seriously injured were wet with sap which ran down the fruit spurs, discoloring the bark of the large branches, while bud scales, leaf stipules, blossom bracts, sepals of unopened blossoms and margins of leaves were blackish or discolored. On May 9 Kieffers were in full bloom, and there was a marked contrast between the healthy and affected trees because those that were much injured appeared as if struck by blight. On fruit spurs there were dead buds and many brownish shriveled blossom clusters, while the leaves were small and cup-like with blackened margins. During blossoming the larvæ appeared, injuring the tender leaves and causing them to be deformed. About Germantown Kieffers suffered the most and there was scarcely an orchard of this variety that did not show evidences of the work of the thrips. While some fruitgrowers lost a goodly percentage of their crops, the thrips was not equally destructive in all orchards. Its work was spotted and showed up more on some trees or in some orchards than others. The reduction in fruit yields varied apparently in proportion to the numbers of the thrips and the severity of the attack. On the whole the Kieffer crop of 1911 was much more satisfactory than that of the preceding year. Seckel orchards were oftentimes similarly injured while Bartletts and Clapp Favorites, though showing considerable blighting of blossom clusters in different plantings, were not in the main seriously affected. The almost complete destruction of blossom clusters was observed on trees of Beurre Bosc, Beurre Anjou, Vermont Beauty, Dana Hovey, Clairgeau, Rhode Island and Vicar of Wakefield. As these varieties are not grown extensively the losses to these crops were locally of comparatively little importance.

Apples were generally infested with thrips, but the destruction of blossom clusters was not so common as with the pears. In spite of the presence of large numbers of the thrips in the buds there was usually a large setting of apples. While all of the leading commercial varieties were more or less infested by the thrips,

the most conspicuous injuries to blossom and leaf clusters during the past season were observed with such varieties as Astrachan, Gravenstein, McIntosh, Ben Davis and Oldenburg. Proximity to pear and sweet-cherry plantings rather than varietal susceptibility may be the true explanation for the differences in the extent of injury among these fruits.

Sweet cherries, including such varieties as Black Tartarian, Napoleon Bigarreau, Schmidt Bigarreau and Windsor, the leading commercial sorts, were frequented by large numbers of the thrips from the time of the spreading of the winter bud scales to the dropping of the blossoms. Bearing in mind the destructiveness of the thrips to this fruit in California, careful observations were made to ascertain the effects of the pest upon sweet cherries. While the conditions were apparently favorable for its activities it caused very little harm. In spite of the abundance of the insect the trees produced good yields and the fruit was of superior quality. The most noticeable work of the insect showed on the stems of the cherries, which were scarred and rough in outline as a result of the incisions made by the adult females in depositing their eggs; and on the leaves, which were spotted with pale areas and were full of holes through the feeding of the larvæ and adults on the undersurfaces. The effects of oviposition upon the stems of cherries will be studied closely in the future as nearly all growers state that the yellowing of cherry stems is of quite common occurrence and is frequently attended by early dropping of much of the fruit. This has been attributed to imperfect fertilization, but it is possible that under some conditions the deposition of eggs by the adults weakens the cherry stems and induces premature dropping. Larvæ were observed in large numbers under the husks or loose calyces of the fruits and although they caused abrasions in the surfaces of the cherries such injuries were of no material importance.

Sour cherries such as Montmorency and Morello showed similar injuries but to a less extent than upon the sweet sorts. Plums were generally infested with the thrips and its work upon fruit

stems and foliage could be seen in most plantings. Blossoms of apricots, peaches and quinces were also rarely free from adult thrips.

SPRAYING EXPERIMENTS IN THE HOVER ORCHARD.

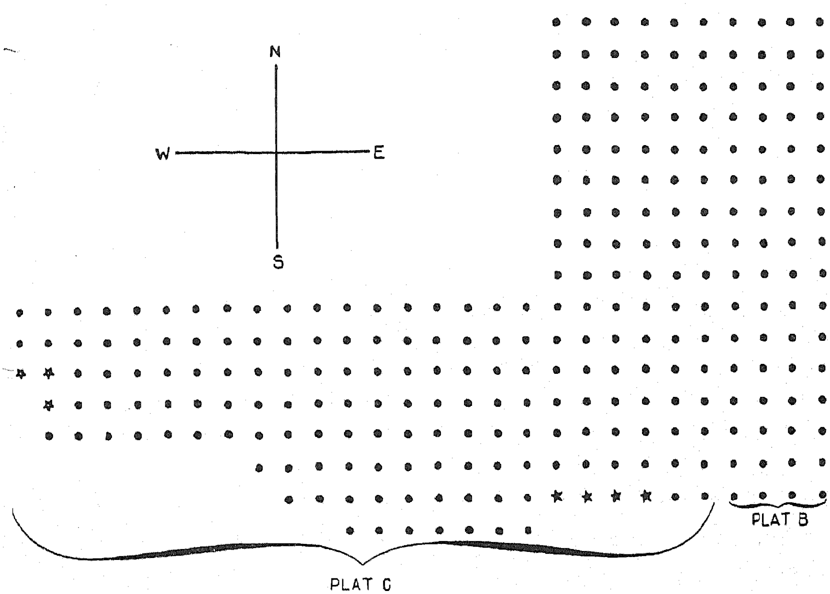
The early discovery of the thrips during the past spring enabled the Station to carry out a number of spraying experiments to determine methods for the protection of orchards. Besides, opportunity was also afforded to assist a number of fruitgrowers to determine what they could accomplish by spraying under their own conditions. Of these efforts the experiments conducted in the Kieffer orchard of A. W. Hover & Brother were the most successful. As they are very instructive as to the difficulties of the problem and as to the requirements for efficient work against the thrips the principal details of the various tests in this planting are discussed quite fully to guide fruitgrowers in future spraying operations.

DESCRIPTION OF ORCHARD.

This orchard consists of about three hundred and thirty-four trees which are nearly all Kieffers, interplanted with a few Bartletts. The trees are fourteen years old and are fifteen feet apart. This planting is located on a warm, protected slope with an eastern exposure, and the soil is a shale loam which is kept in a high state of fertility by cultivation, cover crops and commercial fertilizers. Injuries to the trees were first noticed in 1909, which resulted in an abnormally small yield. In 1910 the showing of blossom clusters was promising, but a severe blighting set in which was not only followed by a total loss of fruit, but the trees received a severe setback because of the destruction of many of the leaf buds and blossom clusters. This orchard is only one of a number belonging to this firm, but on account of its location, which favors an early opening of the buds, the losses by the thrips have always been much more extensive than in other plantings of Kieffers, Bartletts and Clapp Favorites variously located on the farm.

PLAN OF TREATMENT OF EXPERIMENTAL ORCHARD.

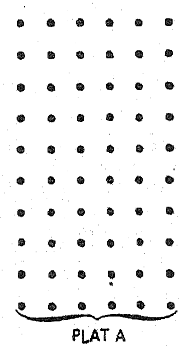
The spraying mixtures used in the experimental tests in this orchard were (1) kerosene emulsion diluted with ten parts of water; (2) Black Leaf 40 in the proportions of ¾ pint of the



PLAT A.— SPRAYS APPLIED:
April 29, kerosene emulsion for adult thrips
May 1, kerosene emulsion for adult thrips
May 11, "Black Leaf 40" with soap for larvæ

PLAT B.— SPRAYS APPLIED:
April 28, "Black Leaf 40" with soap for adult thrips
April 29, "Black Leaf 40" and kerosene emulsion for adult thrips
May 1, "Black Leaf 40" and kerosene emulsion for adult thrips
May 10, "Black Leaf 40" with soap for larvæ
May 12, "Black Leaf 40" with soap for larvæ

PLAT C.— SPRAYS APPLIED:
April 29, "Black Leaf 40" with soap for adult thrips
May 1, "Black Leaf 40" with soap for adult thrips
May 10, "Black Leaf 40" with soap for larvæ
May 12, "Black Leaf 40" with soap for larvæ



* Indicates a check tree

FIG. 5.— DIAGRAM OF THE HOVER ORCHARD, SHOWING SPRAYING PLATS

preparation to 100 gallons of water to which were added 3 gallons of stock emulsion; and (3) Black Leaf 40, ¾ pint to 100 gallons of water and 5 pounds of soap. The accompanying chart shows the arrangements of the plats and dates of the applications of the sprays. The treatments during the period of April 28 to May 1 were made for the purpose of protecting the opening blossom buds and blossom clusters from the adult thrips, while the sprayings from May 10 to 12 were intended to destroy the young larvæ on the fruits and foliage.

DETAILS OF SPRAYING AND RESULTS ON THRIPS.

The first treatment of Plat B was made on April 28, when the most advanced Kieffer buds were quite compact, and at least three days before any blossom clusters separated at the tips. The majority of the thrips were on the outsides of the buds. Quite a few of them were working their way into the ends of the buds, although most of these were still in more or less exposed positions. The nicotine extract with soap was used liberally and the trees were thoroughly drenched. The treatment was, in the main, very effective, killing all of the insects which were wetted with the spray. With the exception of the comparatively few thrips buried deeply in the substance of the buds, the sprayed trees were during the remainder of the day noticeably freer of the insects than the untreated portions of the orchard. While many thrips escaped treatment the effect of the day's work was to encourage the belief that by thorough and repeated spraying the thrips could be reduced to unimportant numbers.

On April 29 the buds were in a condition of growth that favored deeper penetration by the insects and a much larger percentage of the thrips on the trees were within the buds feeding apparently about the pedicels of the rudimentary flowers. Sap, too, was flowing from injured blossom clusters. During the first application of this day's spraying large numbers of the thrips were killed but it was practically impossible to reduce materially the numbers of those well within the compact blossom clusters.

Nozzles adapted to making a rather coarse, driving spray were then attached to the spraying poles and two power spraying rigs were used to apply the mixtures in order to insure the treatment of all of the orchard during the day. Provision was also made for a test of oil emulsion alone or in combination with the nicotine extract to determine comparative penetrating properties. See Fig. 5, Plats A, B, C. With the use of the new nozzles and by taking more pains to direct the spray into the ends of the buds a large percentage of the thrips were killed. The reduction in the numbers of the insects resulted in a conspicuous difference between sprayed and unsprayed trees which began to show on the following day and noticeably increased as the days passed by. The contrast was largely due to the unwithered and freshened appearance of the blossom and leaf clusters of the sprayed trees in comparison with those on the untreated trees which were beginning to turn brown and were now wet with sap. These differences were noted and commented on by quite a number of visiting orchardists in the community. The spraying mixtures seemed to be equally effective. Nevertheless the oil emulsion possesses superior penetrating properties, and as a result of the day's test it is believed that the use of emulsion with the nicotine should make the combination the most desirable spray for the treatment of partially opened buds and compact blossom clusters to reach the hidden thrips.

On May 1 the blossom clusters were generally separated at the tips, and the thrips were now feeding mainly at the points of contact of two flower buds. The entire orchard was sprayed again as outlined in Fig. 5, Plats A, B, C. The exposed positions of the thrips, due to the spreading of the blossom clusters, rendered them very susceptible to all of the treatments and because of the large percentage that were killed no further spraying was deemed necessary for the adults.

On May 10 the larvæ were apparently out in their maximum numbers and were most noticeable in the calyx basins of the young fruits and on the under surfaces of the leaves. To prevent in-

juries to the fruit and foliage and to reduce to the smallest possible numbers the insects that would seek to hibernate in the soil, all of the plats were sprayed with nicotine extract and soap. The larvæ are very readily killed on Kieffer pears, and with the exception of small numbers of them that were feeding along the rolled edges of the unfolding leaves very few escaped the treatment. The damage to the foliage by the remaining larvæ was unimportant.

THE EFFECTS OF SPRAYING MIXTURES ON FOLIAGE.

Notwithstanding the repeated sprayings in a short space of time, in none of the experimental plats did the applications of the nicotine extracts, in combination with soap or kerosene emulsion in the proportions as given, cause any injuries to the tender unfolding leaves. Throughout the attacks by the young and old thrips the foliage of the trees in the sprayed plats presented for the most part a fresh and healthful appearance which contrasted strongly with that of the untreated trees. There was also no apparent checking of the new growth, which appeared to be of normal vigor and amount. In some orchards kerosene emulsion when used alone in strong mixtures caused considerable injury both to the foliage and bark of the young wood. The emulsions were apparently stable, but they proved, in spite of the great dilution, to be the least safe of the spraying mixtures when used in quantities to drench the trees, as is necessary for the successful control of the thrips.

DISCUSSION OF RESULTS.

In its appearance and habits the thrips is quite different from all other insects which the pear growers in this State have been accustomed to combat. It also has the reputation of being a very difficult species to control satisfactorily, which has been well borne out in this season's work. The insect is more susceptible to spraying than any other measure, but it is a formidable pest to combat by even these means because it works rapidly and the prospects of

a crop may be ruined in a few days through the destruction of rudimentary blossom parts, and because of the repeated spraying and thoroughness of treatments required to destroy the thrips concealed in the partly opened buds.

In this season's work at Germantown two factors greatly favored the experimental operations: the relatively small size of the pear orchards in the community, which permitted thorough spraying of entire orchards by power outfits on successive days, and the rapid development of the buds owing to unseasonable hot weather during the latter part of April which made the thrips more exposed to treatment than if the growth of the buds had been less rapid.

Under the conditions which prevailed this year spraying proved very efficient, and no treatment was made which did not effect a considerable reduction of the numbers of thrips in the different plats. Two or three sprayings on successive days reduced the adult thrips to a very small percentage of those that were originally present on the trees. The larvæ on pears proved especially susceptible to treatment, and in the Hover orchard very few escaped, which should greatly simplify future operations in this planting for this pest.

In view of the history of the thrips it is not desirable to draw conclusions on a single season's experiments as the problem may take on new aspects under different seasonal conditions. It is the intention of the Station to continue its investigations on the thrips until efficient methods of control have been satisfactorily demonstrated. The purpose of this bulletin has been largely to encourage spraying as the most promising remedy for the present, and to make more available locally the knowledge that exists on a new and important fruit pest.

METHODS OF TREATMENT.

FORMULAS OF SPRAYING MIXTURES.

1.

Nicotine extract 2.7 per ct. (Black Leaf) .... 6 qts.
Water .... 100 gals.
Soap[1] .... 2 to 5 lbs.
or
Kerosene emulsion .... 3 gals.

2.

Nicotine extract 40 per ct. (Black Leaf 40) .... ½ to ¾ pt.[2]
Water .... 100 gals.
Soap[1] .... 2 to 5 lbs.
or
Kerosene emulsion .... 3 gals.

DIRECTIONS FOR SPRAYING.

In spraying, two objects should be kept in mind,—(1) *to kill the winged thrips working in and about expanding buds and blossom clusters to prevent injury to the tender flower and leaf parts; and* (2) *to destroy the larvæ after petals drop to reduce the numbers of insects which will mature in the ground.*

[1] The addition of soap or kerosene emulsion to the nicotine preparation increases its adhesive and penetrating properties. According to Foster and Jones, (U. S. Dept. Agr. Ent. Circular 131), a combination distillate-oil emulsion and nicotine solution is given preference to all other sprays. The spreading properties of the oil makes this mixture especially efficient against the thrips concealed in the buds.

Directions for making kerosene emulsion are as follows:

Kerosene .... 2 gals.
Whale-oil or fish-oil soap .... ½ lb.
Soft water .... 1 gal.

Dissolve the soap, which has been finely divided, in one gallon of boiling water. Remove the vessel from the stove and add the oil. Then agitate the mixture violently for from three to five minutes by pumping into itself under high pressure until a creamy mass is formed, from which the oil does not separate. Fruitgrowers are advised not to employ an emulsion which shows a separation of the oil as applications of such preparations may cause injuries to the trees.

[2] Experiments conducted in California (See Circular 131 mentioned in Footnote 1) show that the Black Leaf 40 may be used effectively in the proportions of one-half pint of the extract to one hundred gallons of water. In the Station's tests three-quarters of a pint was always used. Future experiments may show that the latter amount is unnecessarily strong and that the smaller quantity of the nicotine extract may be safely used. It should also be stated that on account of greater concentration the express and other transportation charges for Black Leaf 40 are much less than for the Black Leaf, and during the past season the former was, on this account, preferred by pear growers about Germantown.

The period for effective spraying against the adult or winged thrips is during the time when the buds are swollen and partly open and until they are entirely opened at the tips. The first treatment should be made as soon as the thrips become numerous on the trees. The number of the applications required will depend on the thoroughness of the treatments. The grower should spray on successive days or every few days until the thrips are reduced to comparatively few individuals. Two, or certainly not more than three, sprayings are required to afford efficient protection to the trees from the adult thrips. Especially hard to kill are the insects within the buds, as they are often hidden; and it is difficult to force the spraying mixture in between the growing structures of the bud. While it is not possible to reach all of these, many of them may be destroyed by careful work in applying the sprays. By successive applications important injuries may be largely or entirely prevented. *To derive the greatest benefits from the treatments, apply the spraying mixtures in liberal quantities as a rather coarse driving spray, holding the nozzle fairly close to the buds in order to force the liquid into the ends of the buds.* The "angle nozzles" of the large chamber type or nozzles set on an angle to the extension rod, maintaining a pressure of not less than one hundred fifty pounds are preferable for this purpose.

The larvæ may be seen in large numbers as small, whitish creatures in the calyx cups; and on pears especially they are much exposed to spraying because of the open nature of the blossom ends of the young fruits. One or two careful sprayings will practically free the trees of the insects. In making an application both surfaces of the leaves and the calyx ends of the young fruit should be thoroughly wetted by the liquid. Spraying for the larvæ is important because it will greatly reduce the numbers of the insects which seek shelter in the ground until the following spring. The accumulative benefits from the destruction of the larvæ for successive years, while not as yet definitely known, must be considerable.

CULTIVATION.

According to Moulton, experiments have clearly demonstrated that deep fall plowing is an efficient aid to spraying if it is done at a proper time and with care. The thrips undergo their pupal development during the late fall and early winter, and when in this stage they are apparently, under certain conditions, susceptible to disturbances of the soil. For prune orchards in California Foster and Jones recommend plowing to the depth of seven or eight inches during the months of October and November, followed by harrowing; and then cross plowing eight or nine inches deep with subsequent harrowing. On the other hand it is also stated by them that on certain fruit areas in that State such treatment, especially for pear orchards, has not given as satisfactory results as have been obtained in other localities.

Fall plowing of orchards in New York is not regarded with favor by most orchardists, and moreover an opinion prevails that such practice on the lighter soils is attended with risks from winter injuries. In view of the absence of data showing effects on both trees and the insect, fall plowing of orchards for the thrips in this State should be pursued advisedly and in an experimental way.

GENERAL CARE OF ORCHARD.

Severe attacks by the thrips are a serious drain on the vitality and productiveness of the trees. In their weakened state they are also more subject to injuries by adverse weather or environment, and to attacks by various wood-boring insects. The needs of the orchard with respect to cultivation, fertilizers, pruning and spraying for other insects and diseases should be carefully considered in order that the most favorable conditions for recovery to health and productiveness may be afforded to the trees.

THE GRAPE LEAF-HOPPER AND ITS CONTROL.*

F. Z. HARTZELL.

SUMMARY.

The grape leaf-hopper is an important pest of the grape and during the past two years it has been on the increase in Chautauqua county. In many vineyards the necessity for efficient methods of control has been apparent. The insect weakens the vines by piercing the epidermis of the under side of the leaf and sucking the cell sap, thus injuring the cells and exposing them to the drying action of the air. This injury results in a decrease in the amount of wood, and it also affects the quantity and quality of the fruit. Fruit from badly infested vines is poorly ripened.

The leaf-hopper is a sucking insect and lives on the under sides of the grape leaves. Eggs are laid during June by the overwintering adults, and by the beginning of July the young nymphs are on the vines in abundance. These nymphs pass through five stages or instars before becoming adults. Nymphs of the first brood mature during the latter part of July and early part of August, and during normal seasons many of them lay eggs from which develops a partial second brood. During 1911 a complete second brood was observed. Young nymphs of the first instar were found as late as October 1. Most of these nymphs become adults before the leaves drop from the grape vine. The adults hibernate among rubbish, grass, weeds and fallen leaves. They are active during the warmer days of the hibernating period and feed on various grasses, preferring the leaves of bush fruits during the spring before returning to the young foliage of the grape vines.

During the summer the adults are of a yellowish appearance being covered with darker yellow lines. These darker areas turn salmon before the insects leave the vines in the fall and they become dark red when the insects are in their winter

* A reprint of Bulletin No. 344, February, 1912; for "Popular Edition," see p. 815.

quarters. As soon as they have fed again upon grape foliage in the spring these areas become yellow.

Experiments have proven that a spray containing 2/100 of one per ct. nicotine is the most effective and safest contact insecticide for the control of the grape leaf-hopper. This must be directed against the nymphs, which are hit by applying the spray to the under sides of the leaves.

The application of the spray for this insect can be done by the usual hand spraying with trailing hose or by an automatic leaf-hopper sprayer which is described in this bulletin. This latter device was developed during the past season and it has done efficient work. With high pressure and proper adjustment of the nozzles the insect can be efficiently controlled.

INTRODUCTION.

The grape leaf-hopper (*Typhlocyba comes* Say) (Fig. 6), or, as it is often called, "grape thrips," is a very common insect in the vineyards of New York State. Although its numbers during years of average infestation are not sufficient to cause apprehension on the part of the growers as a whole, nevertheless each year some grape plantings are injured by its feeding. Its work is especially noticeable in vineyards near woodland or grass-land, which affords good hibernating places for the insects. The grape leaf-hopper, like other insects, has periods of scarcity and abundance, and when abundant it is very destructive, compelling the growers to resort to remedial measures.

During the summer of 1910 it was seen that this insect was becoming very numerous in Chautauqua county, the browned foliage and poorly ripened fruit, resulting from its work, showing plainly in many vineyards. Observations in 1911 soon proved the number of "hopper-infested" vineyards greater than in 1910; in fact, the increase of the insect was so great as to cause alarm on the part of the grape growers, since a large crop of fruit had set which was threatened both in quality and quantity. The attack affected chiefly the quality, although several vineyards showed a marked decrease in the yield between the vines upon which the

leaf-hoppers were killed by spraying mixtures and those not so treated. It is apparent that the numbers of the insect have been approaching the crest of a wave, and one cannot, at present, tell whether the summer of 1911 records the "high-water mark" or whether we are to expect a further increase during 1912. The millions of adults that went into hibernation the past fall would indicate that a favorable winter for the insects will spell trouble for many of the vineyardists, since these adult "hoppers" will feed on the young foliage, and, if numerous, will cause much injury at a time when the grape foliage is tender and the insects are most difficult to kill.

Noting the increase in numbers of the insects in certain vineyards, experiments were conducted in 1910[1] and 1911 to learn better methods of control. Having found an effective remedy, so far as the insecticide is concerned, during the previous year, it early became evident that a better method of applying the material was needed; so more attention was paid the past summer to developing a machine for applying the material than to efforts in finding cheaper spraying materials. This bulletin has to do largely with the results of experiments and the description of the machine devised for applying the spray.

THE INSECT AND ITS WORK.

HABITS.

The grape leaf-hopper belongs to the group of insects that obtain their food by sucking the juices of plants. They are seldom found on the upper surfaces of the leaves but they usually seek the under sides and there do practically all their feeding. While immature the insects, then called nymphs, pass through five stages or instars (Figs. 7 and 8). During the nymphal instars the wings increase from mere swellings in the first instar to large wing pads in the last stage. The adults have two pairs of wings or, more correctly speaking, the front pair of so-called wings are wing

[1] Bulletin 331, N. Y. Agr. Exp. Sta., pp. 568–579.

covers or *elytra* which are held motionless during flight as are the front "wings" of grasshoppers. The true wings are smaller, are used for propelling the insect and are folded under the elytra when at rest. The wing covers rest in the position shown in Fig. 6, covering the insect's body like a roof.

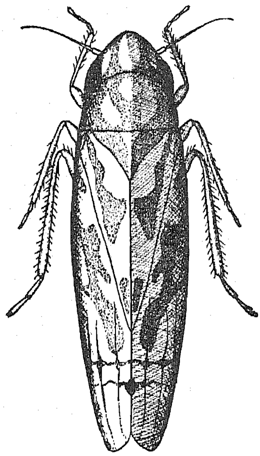


FIG. 6—MATURE GRAPE LEAF-HOPPER.
(Enlarged.)

The adults are more conspicuous than the nymphs and are especially noticeable

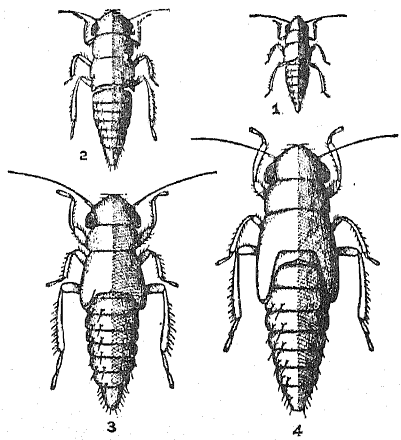


FIG. 7—FIRST FOUR NYMPHAL INSTARS OF GRAPE LEAF-HOPPER.
(Enlarged.)

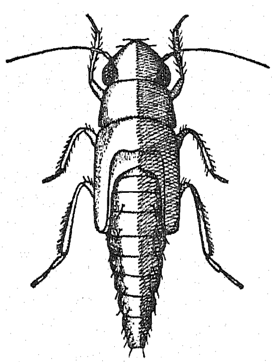


FIG. 8—FIFTH NYMPHAL INSTAR OF GRAPE LEAF-HOPPER.
(Enlarged.)

at the time the grapes are being harvested. They are then very annoying because they get into the mouths, ears and noses of the pickers. At this time they fly about, especially on warm and calm days during the latter part of the season and drift to other vines, or to grass fields, brush land and thickets. In fact, they seek any place that will shelter them during the winter, although many of the insects remain among the fallen leaves in the vineyards.

The adults are about one-eighth of an inch in length and during the summer they appear light yellow in color, but they grow

darker as the season advances, becoming salmon colored before leaving the vines and changing to dark red in their winter hiding places. There are many variations in color and color patterns among individuals of the same species so that nine distinct species have been described; but our leading authorities regard these diverse forms merely as varieties of *T. comes*.

CHARACTER OF INJURY AND ECONOMIC IMPORTANCE.

The grape leaf-hopper, being a sucking insect, secures its food by inserting its proboscis or beak through the epidermis or skin of the leaf, piercing the underlying tissue and sucking up the cell sap. Having satisfied its hunger it withdraws its beak and wanders about the leaf. With the withdrawal of the proboscis the injured leaf tissue is exposed to the drying action of the air which not only completes the destruction of the injured cells but dries out the surrounding cells, thus causing a small portion of the leaf to die. This area is small but the accumulative effect is of importance in the economy of the plant. These injured parts turn yellow and, as the injuries increase by the feeding of the insects, the leaves become dotted with spots until by September these areas are so numerous as to cause the leaves to have a decidedly yellow appearance when contrasted with healthy foliage.

It is not unusual to find 100 leaf-hopper nymphs on a single leaf. If each insect should feed only twice each day and remain on the leaf for a period of two months we would find that there had accumulated on the leaf 12,000 injured areas. This would be a moderate damage; for counts show that leaves of average size, if badly infested, may have as many as 20,000 such injured areas.

Thus there are two factors in the work of the leaf-hopper: the removal of the cell sap by the leaf-hoppers as food; and the destruction of tissue by the drying out and death of the cells surrounding those pierced by the insects. The latter is the more important factor. The death of these cells means a lessening of the growth of wood and a decrease in the yield of fruit. This is evident on

vines that yearly are extensively infested by the leaf-hopper. Likewise serious infestation in any vineyard has a similar influence on the amount of wood produced and the amount of fruit grown. This is cumulative in its effect and can be shown best by weighing the crop from treated and untreated areas year after year. In the aggregate the quantity of fruit lost during years of average infestation has not been conspicuous enough to attract attention. It is in the exceptional years, as in 1901–2, that the loss is sufficient to cause alarm and action on the part of the grape growers. One important effect of average infestation is the *poor quality* of fruit from infested vineyards. The Concord grape when well ripened is dark purple and sweet, but when the leaves are injured by grape leaf-hoppers the fruit has a red appearance and a rather insipid, sour taste. The decrease in the amount of sugar in such fruit makes it especially undesirable for packing in four-pound and eight-pound baskets since choice table grapes should be of excellent quality. Poorly ripened grapes will not be used by the manufacturers of grape juice. Since the best prices are being paid for grapes for these two purposes, it follows that the leaf-hopper may cause serious loss by depreciating the quality of the fruit. However, growers as a whole pay little attention to the attacks of the "hopper" since grapes of poor quality usually fetch as good prices as superior fruits because of faulty methods in marketing. With the better system of packing and grading grapes, which must come if Chautauqua grapes are to be worth growing, the importance of controlling the pest will generally be better appreciated.

SPECIES AND VARIETIES OF GRAPE LEAF-HOPPER IN CHAUTAUQUA COUNTY.

The species of grape leaf-hopper most common on Concord grapes in Chautauqua county is *Typhlocyba comes* Say. There is much variation in this species, although the typical form prevails. Occasionally one finds variety *octonotata* Walsh. The typical *comes*, during the summer, has zigzag yellow lines and three black spots on the elytra: one on the costal (outer) margin, which is

round and near the apex of the wings; another on the costal margin, which is nearly rectangular and is about half the distance from the base to the apex of the wing, another on the inner margin about one-fifth the distance from the apex to the scutellum. The black spots on the elytra remain constant during the insect's life, but the yellow markings are subject to change. The bright yellow of summer turns to salmon before the insects leave the vine in autumn, and by winter the markings become red. These individuals change again to yellow in the spring after the insects have been feeding on the grape.

The variety *octonotata* differs from the typical *comes* in having a broad, dark median stripe on the scutellum (the triangular piece at the base of the wings) and has a large dark spot on the inner margin near the base of the "wing." During 1911 there were less than one-tenth as many of the variety *octonotata* in the vineyards as of the typical *comes*. On certain varieties of grapes (which are listed later) *T. comes* is practically absent but its place is taken by another species *T. tricincta*[1] Fitch which is rather striking in appearance. This species is seldom found on the Concord in Chautauqua county and so cannot be called a common insect. So far as it has been studied its life history is similar to *T. comes* and it is apparently susceptible to the same treatment.

FOOD PLANTS.

The several species of grape leaf-hoppers doubtless fed originally on the various species of wild grapes that are indigenous to the Lake Erie valley. Since *T. comes* and *T. tricincta* differ in the variety of grapes each infests the food plants of each species will, for the sake of clearness, be discussed separately. *T. comes*

[1] This species is slightly larger than *T. comes* and may be recognized by the following characters: Across the elytra there are three dark bands. The band at the apex is dusky, except a dark spot, and covers the apical fourth of the elytron. The middle band extends across each wing cover, being subtriangular. The outer portions are composed of a black spot almost rectangular in shape and situated about one-half the distance from the base to the apex. From this spot the band widens until it reaches the inner margin, being a dark red. The third band extends across the base of the elytra, the scutellum and the posterior part of the prothorax, and varies from red to purple. The eyes and sides of the prothorax are purple.

feeds chiefly on the species and varieties of grapes having thick leaves with the under sides covered with pubescence. *Vitis bicolor* Le Conte (the summer or blue grape) is the most common species of wild grape in Chautauqua county. It has thick leaves with a downy under surface and it is a common occurrence to find *T. comes* breeding upon it. The varieties of cultivated grapes upon which *T. comes* has been observed breeding are as follows:

Severely infested and badly injured: Agawam, Brilliant, Campbell Early, Catawba, Concord, Delaware, Goff, Herbert, Iona, Lindley, Mills, Regal, Salem, Winchell and Worden.

Badly infested but not as severely injured as the preceding: Brighton, Jefferson, Niagara, Noah, Vergennes and Wilder.

Seldom infested: Bacchus, Clevener and Clinton.

It will be noted that two thin, smooth-leaved varieties, Delaware and Winchell, are included in this list, but all the others are varieties having pubescence on the under surfaces of the leaves, which are thick or moderately thick.

T tricincta breeds on *Vitis vulpina* L. (the frost or riverbank grape) a thin-leaved species of wild grape that is found occasionally in Chautauqua county. It also breeds on the following varieties of cultivated grapes:

Very abundant: Bacchus, Clevener, Clinton and Gloire.

Few to one-half the number present (the other being *T. comes*): Agawam, Brighton, Brilliant, Delaware, Herbert, Iona, Lindley, Mills, Salem, Vergennes and Wilder.

The tendency of this species to select smooth-leaved varieties is shown, but it should also be noted that it breeds on some of the varieties in common with *T. comes*. It, however, has never been seen by the author breeding on the following varieties: Campbell Early, Catawba, Concord, Goff, Jefferson, Niagara, Noah, Regal, Winchell or Worden, all of which have pubescence on the under surfaces of the leaves.

During the warmer days of the hibernating period both species feed on various weeds and green plants. Timothy and blue grass afford favorite harbors for them.

LIFE HISTORY.

Emergence in the spring.— When the warm spring days cause the various perennial weeds and other plants to begin growth, the grape leaf-hopper seeks these and feeds upon them, but prefers plants belonging to the bush fruits. They feed on these until the new growth of the grape vines has started, when they migrate to them and feed particularly on the shoots and leaves nearer the ground. It is the lower portion of a vine that first shows the results of leaf-hopper infestation, and the infested leaves turn yellow early in the summer. As the season advances and the lower growths become seriously injured the adult "hoppers" attack the leaves higher on the vines.

Egg stage.—The leaf-hoppers seek the vines during the first two weeks in May and, after feeding for a short time, copulate. The eggs are laid in the tissues of the under sides of the leaves and are so carefully hidden under the epidermis that they are difficult to find. June is the month in which most of the eggs are laid and these give rise to the first brood of nymphs. In an advanced season oviposition may commence as early as the first week in June, but if the year is backward the first eggs may not be deposited until near the middle of this month. The number of eggs deposited reaches its maximum in the latter part of June. Since many of the old hoppers are still alive on the vines when the nymphs reach maturity, it is rather difficult to determine the time of last egg-laying of the over-wintering adults. Of the eggs which are deposited during August the majority undoubtedly are laid by the new brood of adults. The second period of egg laying may last until the middle of September.

Nymphal stage.— During 1911 the first nymphs appeared June 12, and the maximum numbers were on the vines by July 1. Many were changing to adults about July 15. During the latter part of August large numbers of nymphs in various stages of development were again observed. Individuals of the first instar were observed as late as October 1. There is little doubt that the long warm summer season of 1911 produced two distinct broods.

It is the common belief that the species during normal years is limited to a single brood with a partial second brood. By the time the leaves of the grape fall most nymphs have transformed to adults. The question of the number of broods can be settled only by a series of breedings extending through normal and abnormal seasons.

Adults.—As has been mentioned before, the winter is passed in the adult stage. These adults, after returning to the vines in the spring, copulate and the females begin oviposition during June. The over-wintering adults live until August and perhaps longer. Thus one can find this stage of the insect on the vines or among the fallen leaves in the vineyard during the entire year.

EXPERIMENTS FOR THE CONTROL OF GRAPE LEAF-HOPPER.

During the seasons of 1910 and 1911 experiments to find the best method of control for the "hopper" were conducted in the vineyards of Mr. Charles C. Horton, Mr. Mark J. Sackett and Mr. Charles Secord of Silver Creek and during 1911 in the vineyard of Mr. F. A. Morehouse of Ripley. The experiments during 1910 have been discussed in Bulletin 331, and it will be noted that the most satisfactory spraying mixture contained nicotine. The weakest dilution used was one part of "Black Leaf Tobacco Extract" to 100 parts of water. The experiments during 1911 were planned to corroborate the results of 1910 and also to test out various brands of nicotine products and other contact insecticides. About thirty acres of vineyard were used in the experiments.

From the standpoint of effectiveness in the control of the insect, ease of application and safety to the grape foliage, the nicotine sprays have proven the best of the materials tried. The most economical dilution of a nicotine product was found to be that in which the spray material contained 2/100 of one per ct. nicotine. It was demonstrated that with very thorough appli-

cation the younger nymphs were killed with somewhat weaker solutions but that the older nymphs would escape unless the work was carefuly done. On the basis of the nicotine content, the proper dilutions for mixtures to control the grape leaf-hopper are "Black Leaf Tobacco Extract" one part to 150 parts water, and "Black Leaf 40" one part to 1600 parts water.

In the tests it was very apparent that the older the nymph the greater its power of resistance to the mixtures. It required less material to kill the younger nymphs. Even a fine-mist spray will suffice for the very immature insects, but it will not prove effective against the larger nymphs. The adult insects are frequently hit while on the wing, but as a rule they are affected in too small numbers to be considered in the spraying operations.

The experiments also proved that the most satisfactory results can only be attained when the material is applied with a pressure of about 125 lbs. and nozzles are used that throw a coarse spray against the under sides of the leaves. Nozzles throwing a mist spray, even if a high pressure is maintained, will not cover the insects sufficiently to kill them; and nozzles throwing a coarse spray are ineffective with low pressures. This is especially true when using an automatic leaf-hopper sprayer (described below) or when the trailing-hose outfit, operated by hand, is employed. Even with hand-spraying, the men operating the nozzles must be very careful to do thorough work or failure will result. Efficient results were always obtained when the vines were thoroughly sprayed.

One objection to the use of nicotine sprays when applied by means of "trailers" is the saturation of the clothes of the men handling the nozzles. This has caused nausea in several instances and led to attempts by various growers to arrange fixed nozzles to throw the spray on the under sides of the leaves. These devices were failures as they did not do thorough work on vines with heavy foliage. Among the various contrivances that were devised was one made by Mr. F. A. Morehouse which had some good points but, however, several serious faults. In order to

make this workable, improvements were needed, and the author finally devised the machine with three booms with adjustable nozzles. Mr. Morehouse and the author together then developed the complete spraying attachment as shown. (Plates XXXIV–XXXVII.) The machine when used with a pressure of 125–150 lbs. was very effective in killing the nymphs since between 80 and 90 per ct. of the foliage on dense vines was covered with a coarse spray. This outfit is described as follows:

AN AUTOMATIC GRAPE LEAF-HOPPER SPRAYING ATTACHMENT.

DESCRIPTION.

The outfit consists of two frames, one placed on each side of a vineyard sprayer (Plates XXXIV–XXXVII). Each frame (F, Plate XXXVII) is more or less rectangular in shape and is attached to the sprayer by three supports (S) which are bolted as shown in the figure. The frame carries three booms (B) swinging outward from the frame and each is kept pressed away from the frame by means of a spring (A). Near the free end of each boom is placed a cyclone type of nozzle (N) set so as to deliver the spray upward. This nozzle is prevented from tearing the young canes of the grape and at same time is protected by means of the slanting projection (P). The spray material is delivered to the pipe (G) from which it is distributed by hose (H) and pipe connections (C). The upper and middle booms are of different lengths and swing from the forward part of the frame, the shorter being above. The lower boom is of the same length as the middle one but is swung from the upright at the offset in the frame.

This attachment as used in the experiments mentioned before was built under the author's directions by Mr. George Laurie of Silver Creek, who constructed it with the following dimensions and materials: The frame is of ¾-inch iron pipe, being of the dimensions shown in the drawing (Plate XXXIII). Screw threads are cut on the pipes which are fitted into the various elbows and T's used. The supports are ¾-inch iron rods having screw

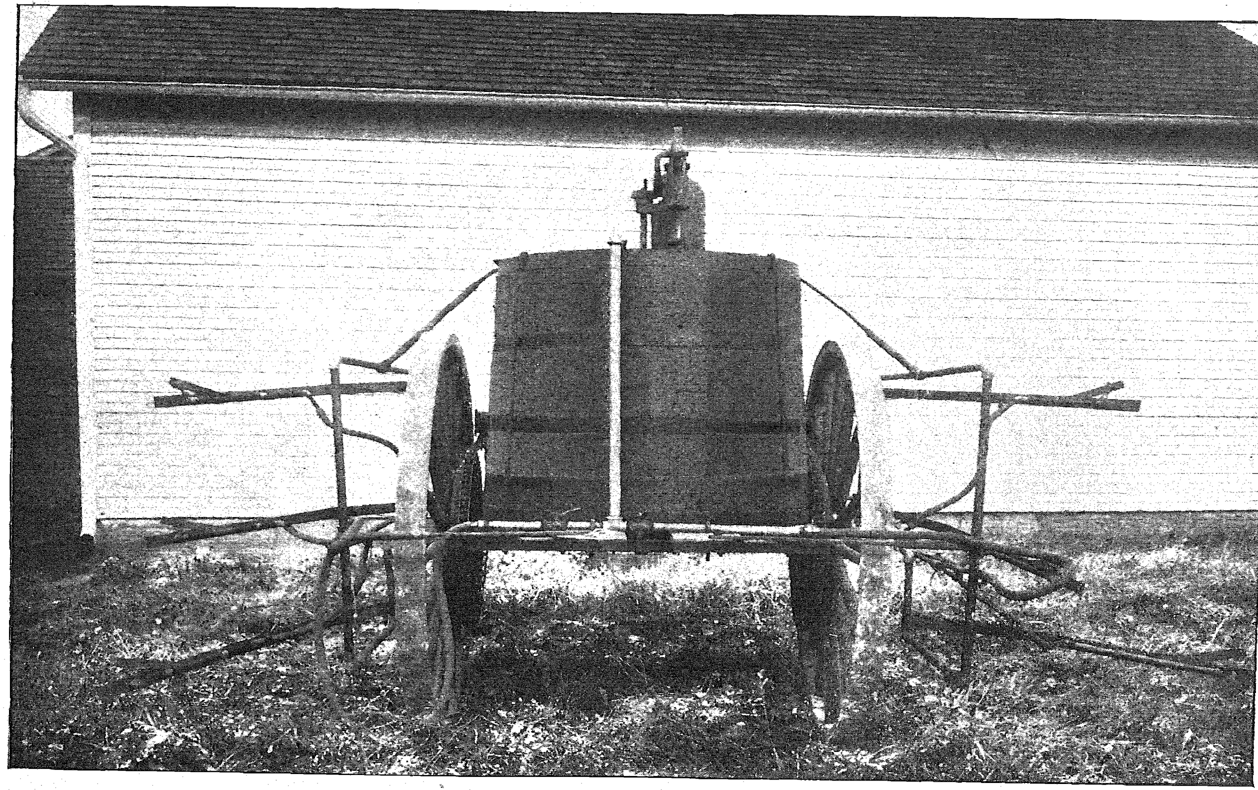


PLATE XXXIV.—GENERAL VIEW, FROM REAR, OF AUTOMATIC GRAPE LEAF-HOPPER SPRAYING ATTACHMENT.

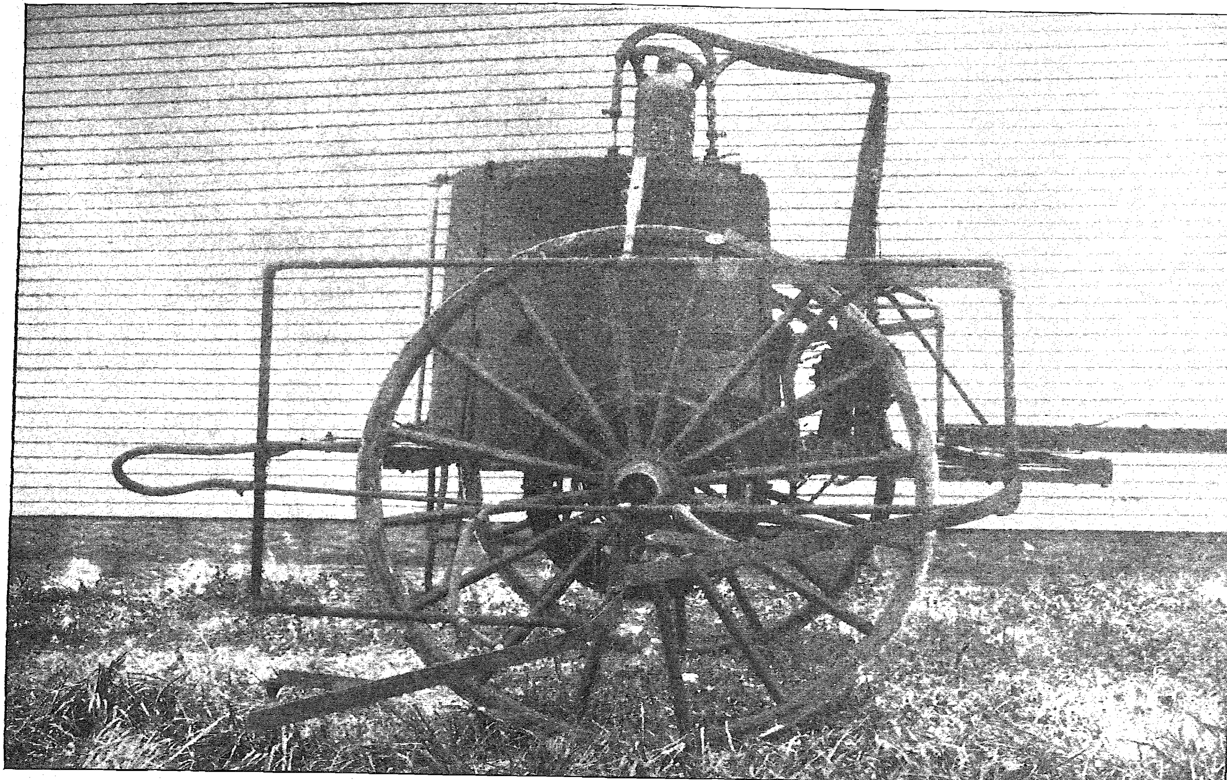


Plate XXXV.—General View, from Side, of Automatic Grape Leaf-Hopper Spraying Attachment.

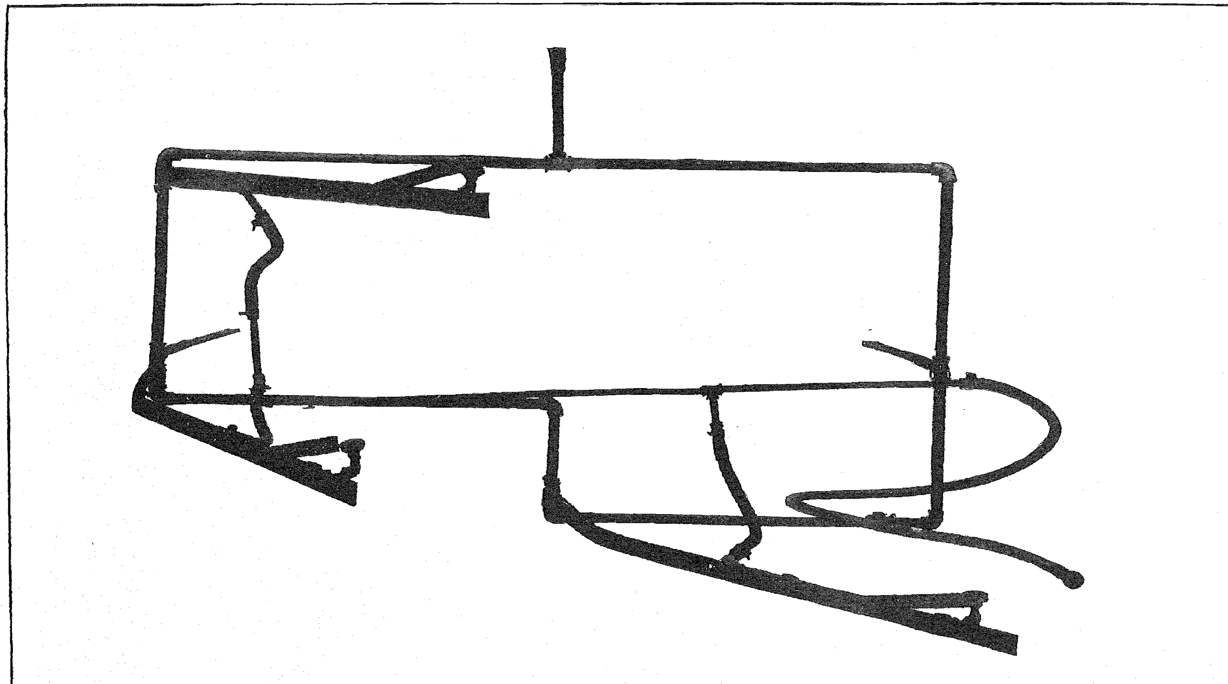


Plate XXXVI.—Automatic Grape Leaf-Hopper Spraying Attachment, Removed from Spray Cart.

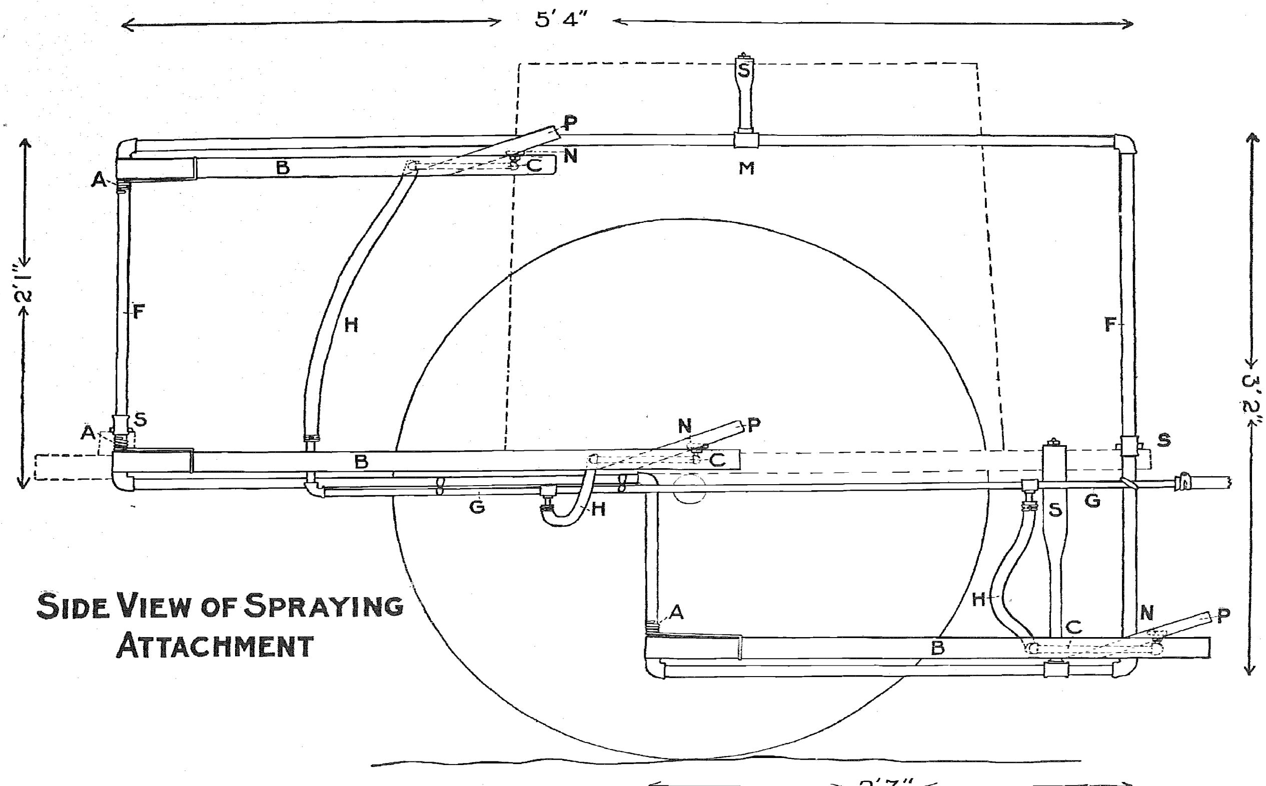


PLATE XXXVII.—DETAIL PLAN OF AUTOMATIC GRAPE LEAF-HOPPER SPRAYING ATTACHMENT.

threads at one end to fit into the T's, and the other end flattened to a width of 1¼ inches with ¼-inch holes drilled about 6 inches apart. The booms are made of $\frac{3}{16}$-inch tire steel 2 inches wide and have the shapes shown in the illustrations (Plates XXXIV–XXXVII). One end of each boom is bent entirely around the pipe, thus forming a bearing. Brass spring wire ⅛ inch in diameter is inserted in a small hole in the pipe and the wire wound about the pipe several times, thus forming a coil spring with the end attached to the boom about one foot from the spring. The springs are above the middle and lower booms, but the spring is below the upper one, thus serving to hold the boom in position. The slanting projection is a piece of tire steel ¾ inch wide, ⅛ inch thick and 6 inches in length. This is riveted to the inner side of the boom about 8 inches from the end and set at an angle of 20°. The nozzle is of the cyclone type with a large apertured disc. The nozzle is connected to a short pipe by means of two street L's which allow the placing of the nozzle in any position. The pipe is about one foot in length, is fastened to the boom end and connects with the hose by means of an elbow and a nipple. The hose is ½ inch in diameter and connects by a nipple fastened to the supply pipe. The lower boom should be about 8 inches from the ground, which would place the middle boom about 1 foot 8 inches and the upper one 3 feet 4 inches above ground. This apparatus is designed for grapes on wires with the rows 8 to 10 feet apart. It can be built by a blacksmith or plumber for less than $20 (not including the cost of the nozzles).

RECOMMENDATIONS.

To obtain efficient results against the leaf-hopper with either the trailing hose and extensions or the automatic grape leaf-hopper sprayer, the following precautions should be observed:

(1) *The spraying must be done at the proper time.*— This time will vary with the season, but in Chautauqua county it is sometime during the month of July. The first nymphs appeared June 12, 1911, whereas the first nymphs for normal years ap-

pear between the 15th and 20th of June. The maximum number of nymphs appeared the last week of June and the first two weeks of July in 1911, but in normal years the maximum numbers appear from about July 4 until the first of August. Spraying should be done when the maximum number of nymphs are present, thus killing the largest number of insects which will usually confine the number of sprayings to one. One must judge the time by watching the development of the insects.

(2) *The proper contact insecticide must be used and at the proper strength.*— The experiments mentioned before show that a nicotine solution diluted until there is 2/100 of 1 per ct. nicotine in the spray material will kill the nymphs. This means that "Black Leaf 40" (40 per ct. nicotine) should be used 1 part to 1600 parts of water, and "Black Leaf Tobacco Extract" (2.7 per ct. nicotine) should be used 1 part to 150 parts of water. Other preparations must be diluted according to their nicotine contents.

(3) *Sufficient spray mixture must be used to drench the insects.*— Where the foliage is dense this is accomplished by means of nozzles adapted to throw a large amount of coarse spray. Nozzles of the cyclone type with *large apertured discs* are preferred. The folly of using a fine mist spray when the foliage is heavy has repeatedly been shown since with nozzles throwing such a spray the leaf-hopper nymphs were not killed in sufficient numbers, even though the spraying mixture contained as high as 5/100 of 1 per ct. nicotine.

(4) *A pressure of from 125 to 150 pounds per square inch is necessary.*— *Use a pressure gage* as the grower may then know the amount of pressure the sprâyer is carrying. Applications at low pressure are a waste of time and material. Experiments conducted with a sprayer carrying the automatic leaf-hopper spraying attachment and operating at from only 60 to 80 pounds pressure were failures.

(5) *The under sides of the leaves must be thoroughly hit by the spray.*— This means that when the spraying is done by the trailing hose and extensions, the work must be done carefully.

If the automatic leaf-hopper sprayer is used, *the nozzles must be set at the proper angles on the booms.* There is no fixed rule. Each nozzle must be set so as to cover the under sides of the most foliage. Usually the nozzle on the lower boom is set to throw the spray vertically, since this boom can swing under the vines farther than the others. The nozzles on the middle and top booms must be set at slightly different angles. The height of the vines, the manner of trimming and the direction of the wind must all be taken into consideration: One should examine the under sides of the sprayed leaves from time to time to see that the nozzles are properly adjusted.

(6) *Drive slow if foliage is dense.*—If one is using a traction sprayer (one in which the power is secured by gearing attached to the wheels of the sprayer) it should have a pump of sufficient capacity to maintain a pressure of 150 lbs. per sq. in., using six large apertured nozzles and driving slowly. With gasoline engine sprayers it is necessary to have an engine and pump of sufficient capacity to carry the required pressure with six large nozzles.

Spraying as directed one would use nearly 150 gallons of spray material per acre where the foliage is dense. Where vines are weak or young and the foliage is not dense, one can secure good results by using discs with slightly smaller apertures, thus using less spray per acre. One's judgment must govern him in the use of material economically.

With the use of 150 gallons of material per acre, using the nicotine preparations at the present prices, it would cost about $1.25 per acre for material to control the grape leaf-hopper for a season.

THE APPLE AND CHERRY ERMINE MOTHS.*

P. J. PARROTT AND W. J. SCHOENE.

SUMMARY.

During recent years colonies of the caterpillars of the apple and cherry ermine moths have been discovered in considerable numbers in the State of New York. These insects were introduced in shipments of foreign nursery stock and appeared in plantations of imported apple and cherry seedlings. According to the records of the Division of Nursery Inspection infested plants have been found at Lockport, Hilton, Chili, Dansville, Rochester, Penfield, Newark, Orleans, Seneca and Geneva in western New York; at Johnstown and Schoharie in the Mohawk Valley region, and at Blauvelt, in the Hudson River Valley.

From the material that has been collected two species of moths were bred — *Yponomeuta malinellus* Zell., which thrives largely on apple, and *Y. padellus* L., which is a more general feeder, showing preference for hawthorn, plum and cherry. Both species are common and destructive fruit pests in Europe.

The adult insects are small moths, with snowy white, black-dotted anterior wings. The hind wings are gray or leaden in color, with long fringes on lateral and posterior margins. The wing expanse is about 20 mm. The caterpillars are quite variable in color, ranging from pale to grayish or greenish brown, and they average about 15 mm. in length. They have web-forming habits and live in a common web, and in this they spin their cocoons.

In the studies on the life history of these insects during the past four years the moths appeared during the first two weeks in July, and oviposition began about the middle of this month. The eggs are deposited in oval-shaped masses near a bud, usually of the current year's terminal growth, and less frequently on the older wood. Hatching takes place in early autumn and the young larvæ remain through the winter under the protecting crust of the egg shells. In the spring they assemble among the tender leaflets of an adjacent bud, which they attack. The older caterpillars feed openly on the foliage under the protection of a thin, grayish web. With the need of more food they extend their webs, seizing and involving fresh leaves in a common nest. In severe attacks trees may be defoliated and completely covered with the silken tents of the insects. Pupation took place during the latter part of June and early July and the moths lived from the beginning of July to about the middle of August.

* A reprint of Technical Bulletin No. 24, November, 1912.

These insects have, in their normal habitat, a large number of natural enemies, the most important of which belong to the orders Hymenoptera and Diptera. In spite of the large numbers of the moths' eggs imported into the United States, the lepidopterons were apparently unaccompanied by their more common and efficient parasites. An ichneumon, *Mesochorus* sp., was obtained from *padellus* reared on cherry, and a tachinid, *Exorista arvicola* Meigen, was quite abundant in some colonies of *malinellus* caterpillars subsisting on apple.

Comparisons of the structures of the caterpillars and of the male genitalia show no tangible structural differences between *padellus* and *malinellus*. The absence of differential features suggests that the moths from hawthorn and cherry and those from apple constitute a single species; but cross breeding experiments are desirable to settle definitely the status of the two forms.

An outbreak of these insects is to be expected from two sources: (1) From the annual importation of infested foreign-grown nursery stock, and (2) from spread of the pests that may have established themselves along the avenues of trade in previous shipments. The remedy is careful inspection of nurseries during June and the destruction of infested plants. As fruit pests, the insects would prove amenable to prevailing spraying practices.

INTRODUCTION.

A study of the insect outbreaks from year to year in the State of New York will impress one with the number of introduced species and their great importance to its fruit interests. These constitute a steady and a severe drain on its horticultural resources. Many of the principal introductions in the past had their origin in Europe, and in the diverse and constantly increasing intercourse with the United States there is a marked trend of migration of the common and destructive species to this country. Common pests of fruit trees in all parts of the continent are certain insects, known as "ermine moths," which are discussed in almost every leading work upon European economic entomology. Interest is now directed to these insects as they have during recent years been brought into this State in considerable numbers in foreign importations of nursery stock. It is desired to call attention to their injurious nature, the circumstances of their discovery and the danger that exists of these pests being introduced, if they have not already become established.

THE ERMINE MOTHS.

GENERAL CHARACTERS.

These moths constitute the genus *Yponomeuta* of the family *Yponomeutidæ*. In Dyar's list of North American Lepidoptera this

family is placed between the Tortricidæ and the Gelechiidæ. The genus is a small one, but it contains a few species which, because of their common occurrence and economic importance, are well-known insects in their normal range of distribution. The moths are small and have an expanse of wings which varies from about twenty to twenty-five millimeters, according to the species. A characteristic feature of these insects is that the anterior wings of most species are brilliantly snowy white, and marked with black dots. The hind wings are generally darker, being grayish or leaden in color, and possess long fringes on the lateral and posterior margins. The caterpillars are gregarious and have web-forming habits. They live in a common web which may involve many twigs and leaves, and in this they spin their cocoons.

HISTORICAL NOTES AND SYNONYMY.

The history and synonymy of *padellus* and *malinellus* are as follows: The former was described by Linnæus [1] in 1758 under the name of *Phalæna (Tinea) padella*,[2] and fruit trees are given as its host plants. Fabricius [3] in 1775 describes the moth, larva and pupa and states that the insect occurs on fruit trees. Believing that it was distinct from *padellus*, Zeller,[4] in 1844, designated the form occurring on apple as *malinellus*. The species described by him as *variabilis* is listed by most writers as a synonym of *padellus*.

Latreille [5] in 1796 describes the genus *Yponomeuta*,[6] and in 1802 [7] he gives *Tinea evonymella* L. as the type. Stephens[8] in 1829 established the family *Yponomeutidæ*. Sodoffsky[9] in 1837 changed

[1] Linnaeus. Systema Naturæ, 10th Ed. **1**: 535. 1758.

[2] *Padella*, so named from *Prunus padus* L., the European bird cherry. The Linnæan names for several of the *Yponomeuta* species are very misleading. *Prunus padus* is the principal host plant of *Y. evonymellus* L., but the insect's name would imply that it lives on Evonymus. This confusion Zeller sought to correct.

[3] Fabricius. Systema Entomologiæ, p. 656. 1775.

[4] *Isis*, p. 220. 1844.

[5] Latreille. Précis des Caractères génériques des Insectes, p. 146. 1796.

[6] This is of Greek origin *ὑπονομεύω* "I mine," and is presumably taken to mean "one who undermines" or "who works under the surface". The derivative *ὑπονομεύτης* belongs to the first declension masculine, and we have therefore used "us" endings in the names of the species.

It should also be noted that words which begin with "upsilon" have the rough breathing, which is represented by the letter "h" in words derived from the Greek, — thus *ὑποκριτής* becomes hypocrite in English. If Latreille had followed this rule he would have designated his genus Hyponomeuta instead of Yponomeuta, but in spite of its unusual formation, which is a modern invention, there appears to be no other choice than to accept his selection.

[7] Latreille. Histoire Naturelle générale et particulière des Crustacés et des Insectes. **3**: 467. 1802.

[8] Stephens. Catalogue of British Insects, p. 193. 1829.

[9] Sodoffsky. Etymologische Untersuchungen ueber die Gattungsnamen der Schmetterlinge, p. 21. 1837.

Yponomeuta to *Hyponomeuta*[1] which was adopted by Zeller, Stainton and other systematic and economic writers. In Dyar's[2] list, 1902, Busck reverted to the original orthography *Yponomeuta*, which we have adopted.

ATTACKS UPON FRUIT TREES; HOST PLANTS.*

Many of the ermine moths attack fruit trees. The most common and destructive species is perhaps *Yponomeuta padellus* L., which feeds principally on the cultivated plum, blackthorn (*Prunus spinosa* L.) and hawthorn (*Cratægus oxyacantha* L.). Taschenberg,[3] Boisduval,[4] Rebaté [5] and Theobald [6] record it as attacking either wild or cultivated cherries. There has been some doubt as to whether *padellus* actually thrives on apples, but many writers including Major,[7] Delacour,[8] Westwood,[9] Stainton,[10] Köllar [11] and Ormerod [12] list this fruit among its host plants. In England *padellus* has been generally regarded as the species attacking apple. Schöyen [13] of Norway states that *padellus* is the common species on apples, and Bos [14] of Holland has observed *padellus* migrating from *Cratægus* to apple trees. Nördlinger,[15] Mokshetsky [16] and Reh [17] record the pear as one of its hosts. Other plants mentioned by various writers are the medlar (*Mespilus germanica* L.), the European mountain ash (*Sorbus aucuparia* L.) and the ash (*Fraxinus excelsior* L.). In describing conditions in Crimea Mokshetsky [16] gives the white willow (*Salix alba* L.) and the spindle tree (*Evonymus verrucosa* Scop.) as the chief host plants, and the larch and the plum (*Prunus domestica*) as less subject to attack.

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[1] See footnote 6 on previous page.
[2] Dyar. North American Lepidoptera, p. 489. 1902.
[3] Quoted from Judeich-Nitsche's Forst-Insektenkunde, **2:** 1069.
[4] Essai sur l'Entomologie Horticole, p. 574. 1867.
[5] La Chenille Fileuse du Prunier, p. 8. 1909.
[6] Insect Pests of Fruit, p. 91. 1909.
[7] Treatise on Insects. 1829.
[8] Essai sur les Insectes, p. 293. 1850.
[9] *The Gardeners Magazine*, **13:** 433–439. 1837.
[10] Lepidoptera Tineina, pp. 58–61. 1854.
[11] Treatise on Insects, trans. by Loudon, p. 226. 1840.
[12] Manual of Injurious Insects, p. 263. 1881.
[13] *Ztschr. Pflanzenkr.*, **3:** 268–269. 1893.
[14] Letter of April 26, 1910.
[15] Die Kleinen Feinde der Landwirthschaft, p. 460. 1869.
[16] The Apple Moth, p. 15. 1907.
[17] Handbuch der Pflanzenkrankheiten (Sorauer), **3:** pp. 271–274. 1909.

* The difficulty of identifying certain of the ermine moths has led to confusion as to the food plants of each. This is especially true of the species *padellus* and *malinellus*, which have unquestionably been mistaken one for the other, and perhaps confounded with other forms of very similar appearance.

Y. malinellus Zell., as the name implies, thrives on the apple, which constitutes its favorite host. Marchal [1] records its occurrence in destructive numbers on the almond (*Amygdalus communis* L.). Dahlbom, according to Kaltenbach,[2] included the wild service tree (*Sorbus torminalis* Crtz.). It has not generally been considered as a British species, but on the other hand Theobald [3] asserts that it exists in that country on apples and has been confused with *padellus*. Kuwana [4] states that while *malinellus* occurs most commonly on apples in Japan, it nevertheless may feed on the sand pear (*Pyrus sinensis* Lindl.), the Chinese flowering apple (*P. spectabilis* Ait.), the quince (*Cydonia vulgaris* Pers.), the peach (*Amygdalus persica* Sieb. and Zucc.), the Japanese flowering cherry (*Prunus pseudo-cerasus* Lindl.), and the apricot (*Prunus armeniaca* L.).

Besides these two moths there are several other species of relatively minor importance which are recorded as attacking fruit trees; and these are respectively as follows:

Y. mahalebellus Gn., which is recorded by Marchal [1] as common on the Mahaleb cherry.

Y. cognatellus Hb. is very similar in appearance to the foregoing species, and according to Wahl [5] and Kirchner [6] is a common pest on cultivated plums. Mokshetsky [7] records it also upon the Mahaleb cherry and apple.

Y. irrorellus Hb. occurs, according to Hess,[8] principally on the spindle tree (*Evonymus europæus* L.) and sometimes feeds on plum.

Y. rorellus Hb., which is said to be similar to *padellus*, commonly thrives on the willow. Rössler,[9] however, reported its occurrence on cultivated plums.

Y. evonymellus L., which is quite readily distinguished from other species by its size and larger number of black spots on wings, breeds chiefly on the European bird cherry (*Prunus padus* L.). Lunardoni [10] reports it upon cultivated cherries, and Theobald [3] on both cherries and apples.

COMMON NAMES.

As they are quite common insects and are widely distributed throughout Europe, these moths have been designated by many local and popular names: Delacour [11] called *padellus* "La teigne hermine", the "Ermine moth", which was suggested by the anterior

[1] *Bul. Soc. d'Étud. et Vulg. Zool. Agric.*, p. 17. 1902.
[2] From Kaltenbach's Die Pflanzenfeinde, p. 194. 1874.
[3] Insect Pests of Fruit, p. 91. 1909.
[4] Letter of Mar. 31, 1911.
[5] Die Bekämpfung der Gespinstmotten, p. 4. 1907.
[6] Die Obstbaumgespinstmotten, p. 3. 1905.
[7] The Apple Moth, p. 15. 1907.
[8] Die Feinde des Obstbaues, p. 259. 1892.
[9] Quoted from Kaltenbach's Die Pflanzenfeinde, p. 169.
[10] Mentioned by Marchal in *Bul. Soc. d'Étud. et Vulg. Zool. Agric.* 1902, p. 23 (footnote).
[11] Essai sur les Insectes, p. 293. 1850.

silken white wings punctuated by black spots. This name has generally been accepted for popular usage in England, where these moths are known as the "Small",[1] or "Little, ermine moths". Species of economic importance in that country are commonly referred to as the "Hawthorn ermine moth" or the "Apple ermine moth", etc., according to the host. Judeich-Nitsche[2] designated this group of moths as "Schwarzpunktmotten", which obviously was also suggested by the aspect of the front wings. The gauzy texture of the webs or tents spun by the caterpillars doubtless led Jablonowski[3] of Hungary to call these insects "Pókhálós Molyok", "cobweb moths", and in taxonomic treatises by German writers these insects are frequently referred to as the "Gespinstmotten", which again suggests their web-spinning habits.

The more destructive species have received a variety of names throughout their range of distribution. Particularly is this true of the form attacking apples which in England is known as the "Apple ermine moth" (Theobald, Collinge); in France as "La chenille fileuse du pommier" (Rebaté) or "L' hyponomeute du pommier" (Marchal); in Germany and Austria as the "Apfelgespinstmotte" (Wahl, Kirchner, Hess); in Norway as "Eplespindmol" (Schöyen), in Sweden as "Apelspinnmal" (Lampa); in Crimea as "Yablonnaya mol", the "Apple moth" (Mokshetsky); and in Japan as the "Ringo no sumushi", the "Apple veil worm," or "Ringo kemushi", the "Apple caterpillar" (Kuwana). These also indicate the importance which is attached to this species as a destructive pest of the apple.

ECONOMIC IMPORTANCE.

The ermine moths are regarded abroad as very destructive pests of fruit trees, and because of their importance to horticultural interests, standard European works of reference on orchard insects usually contain a very complete account of these species. *Y. padellus* has largely derived its reputation for destructiveness from its attacks on hawthorns and plums, and with these some writers would also include cherries and apples. During certain seasons it is a very common pest on hawthorn which may be rendered very unsightly

[1] The prefix "little" as frequently used by British entomologists in this connection is apparently employed for the purpose of distinguishing these moths from some arctiid species which are of somewhat similar appearance but are much larger. Kappel and Kirby in British and European Butterflies and Moths (1895) mention the following species: Ermine moth (*Spilosoma lubricipeda* Fabr.); Water ermine moth (*Spilosoma urticæ* Esp.) and White ermine moth (*Spilosoma menthastri* W. V.). In this connection it is also of interest to note that Riley in "Shade Trees and their Insect Defoliators", U. S. Dept. Agr. Ent. Bul. 10, referred to the form *punctatissima* of *Hyphantria cunea* Drury as the "Many spotted ermine moth", while Smith in Economic Entomology, p. 266, designates *Spilosoma virginica* as the "White ermine moth".

[2] Forst-Insektenkunde, 2: 1067.

[3] A Gyümölcsfák és a Szóló Kártevó Rovarai, p. 45. 1902.

by being stripped of the foliage while the bare wood is covered by the conspicuous webs or tents of the insects. In the leading plum-growing districts of France, such as the "Départements" of Lot-et-Garonne, Tarn-et-Garonne, Lot, Dordogne and Gironde, this species constitutes one of the chief pests of this fruit. Rebaté and Bernès report that serious outbreaks of the insect occur periodically. In an account of the history of the pest in the Département of Lot-et-Garonne they state that in 1843 all trees were attacked and from 1867 to 1871, in 1882 and again in 1888 much damage was done by it. There was an outbreak in 1901 which was followed by a more severe one in 1902, and it was not until 1904 that its injurious attacks ceased. During 1908 the caterpillars again increased to destructive numbers and serious depredations to plums occurred during 1909.

The apple is especially susceptible to attacks by the ermine moth and wherever this fruit is grown in Europe this insect is one of the most common and destructive pests. In 1838 according to Maurice Girard,[1] "the farmers of Normandy [France] beheld the distressing spectacle of [apple] trees stripped of their foliage and covered with thousands of caterpillars. These, having nothing more on which to subsist hung here and there suspended in enormous masses within a web, while the trunks of the trees were enshrouded with a silken web which concealed the bark. Not only was the crop destroyed in various cantons for several years, but a large number of trees in full bearing succumbed to the injuries." Marchal reports that in certain areas of France *malinellus* appears almost every year in more or less destructive numbers, and that in some communities where there have been serious outbreaks for successive years almond trees have been killed. This species was, in 1902, very abundant and destructive throughout France.

Theobald regards *malinellus* as an important pest of apples in England. According to Whitehead[2] an Yponomeuta caused "exceeding destruction in this country in 1865. It was also very troublesome in most of the large apple-producing districts in the year 1877 and in some few places again in 1880. * * * Whole orchards were entirely devastated in the two first-named years, so that at the commencement of July the trees were as bare of foliage as in December. Leaves, blossoms and fruit were all cleared off by the innumerable caterpillars which not only devoured every particle of these, but also actually began to gnaw the most tender portions of the fruit-bearing spurs. Not only did they utterly ruin the crop in these seasons, but they also injured the trees so extensively that they only yielded a small crop in the subsequent seasons."

Reh[3] writes that *malinellus* was a great scourge in Germany during 1910, and that apple trees were seriously affected.

[1] Quoted from G. Barbut, *Le Progrès Agricole et Viticole*, p. 307. 1899.
[2] Rept. Inj. Ins. to Fruit Crops No. 3, p. 68. 1886.
[3] Letter of June 27, 1910.

Lampa records that in 1908 *malinellus* ravaged apple orchards generally in Onsala and Fjäre in the Province of Holland, Sweden. In one orchard all trees were completely attacked, not a single one escaping. A lesser attack occurred in 1909. During the outbreak of this year the trees were defoliated in five days and were so covered with webs that they had the appearance of a " fur coat ".

According to Mokshetsky *malinellus* has caused much damage to apple orchards, especially in the regions of Russia subject to dry climate. It is a common insect in fruit plantings, but from time to time it increases to incredible numbers. These outbreaks are of a periodical nature and coincide with years of exceptional droughts, approximately once in ten years. Such took place in 1874–75, in 1884–86, in 1894–96, and lastly in 1904–05. Orchards that are severely attacked have the leaves all eaten off, standing as bare as in winter, and are merely covered by a web containing worm-eaten fragments and clusters of the cocoons of the moth. The remnants of the leaves dry up and redden. In consequence of the heat of summer, growth is slow, and under such conditions the production of fruit may be checked for several years. According to Schreiner the yearly loss to the apple crop in the Government of Saratov alone approximates three million marks.

Kuwana says that it is one of the most troublesome insects of apple growers and is a familiar species to most persons in the apple-growing regions of northern Japan. The conspicuous feature of its damage is the defoliation of the trees.

Saracomenos says that a large number of fruit trees, such as apple, pear and plum, which are grown on an extensive scale on the Island of Cyprus, are attacked by *padellus* and *malinellus*. These insects may not only destroy the crops, but if they appear in large numbers for a series of years they may also cause the death of the trees. Other writers in still different fruit-growing regions of Europe comment in like manner on the destructive capacity of these insects.

DISTRIBUTION.

These two moths are generally distributed throughout Europe. The form *padellus* occurs in England, Scotland and Ireland, and on the continent, ranging from Norway and Sweden to the north and Italy and the Island of Cyprus to the south. Staudinger[1] and Rebel mention in its range of distribution Sarajevo, Croatia, Fiume, Dalmatia, Siebenbürgen, Roumania, West Bulgaria, Greece, Armenia and Tura (West Siberia). According to Köppen it probably occurs over a greater part of European Russia and Turkestan.

The associated form, *malinellus*, has a range similar to the foregoing species. Mokshetsky states that in the extreme northwest of Russia and in Poland, where there are many orchards of the

[1] Ann. d. K. K. Naturhis. Hofmus. Wien, 1904, p. 346.

principal varieties of apples, the moth occurs only in trifling numbers; but it is most severely felt in southern and middle Russia where the dry, continental climate of this region seems to be more favorable for the propagation of the insect. Its distribution is largely confined to the area of apple growing, which is bounded by the governmental states of Livonia, St. Petersburg and Viatka on the north to Taurida, Saratov and Kursk southward. Unlike *padellus* this moth occurs in Japan, and according to Kuwana it is very common in the kens or prefectures of Hokkaido, Aomori, Akita, Iwate, Yamagata and Nagano, all of which are in the northern and eastern portions of the kingdom.

BIOLOGY OF THE ERMINE MOTHS.

LIFE STAGES OF *padellus*.

Egg.— The eggs are deposited in masses, usually oval in shape, which are elongated in the general direction of the twig on which they are situated. The egg mass appears as a reticulated disk or pellicle, which is flattened but slightly convex, and is closely attached to the bark. The dimensions are generally from three to five millimeters in length and upwards of four millimeters in width, but the egg masses vary much in size as well as in shape, depending on the number of eggs they contain and their accommodation to the positions on the convex surfaces of the twigs. Not infrequently they very much resemble a eulecanium scale in its earlier stages of development. The individual egg has the appearance of a flattened, yellow, soft disk, oval in shape, with the central area slightly raised, and marked with longitudinal ribbings. It measures about seven hundred microns wide and eight hundred to nine hundred fifty microns in length. The eggs are arranged in rows and are superimposed on one another like tiles on a roof, the imbrication being very noticeable under slight magnification. The number of eggs in an assemblage is variable,[1] running in some instances to only a few, but ordinarily upwards of fifty to eighty in a mass. At the time of deposition the egg mass is covered with a glutinous substance which on exposure to the air forms a resistant protective covering. This is at first yellow, but with the progress of embryonic development it becomes mottled with red and later turns brownish or greyish brown, thus resembling in color the bark on which the eggs are attached. The eggs are usually placed near a bud of the current year's terminal growth and less frequently on the older wood.

First larval stage.— Length about 1 mm., ranging from about eight hundred to nine hundred and fifty microns; head, cervical

[1] The smallest number of *malinellus* eggs observed in a cluster on seedlings was nine, and the largest number was eighty-three, while the majority of egg masses had between thirty and forty eggs.

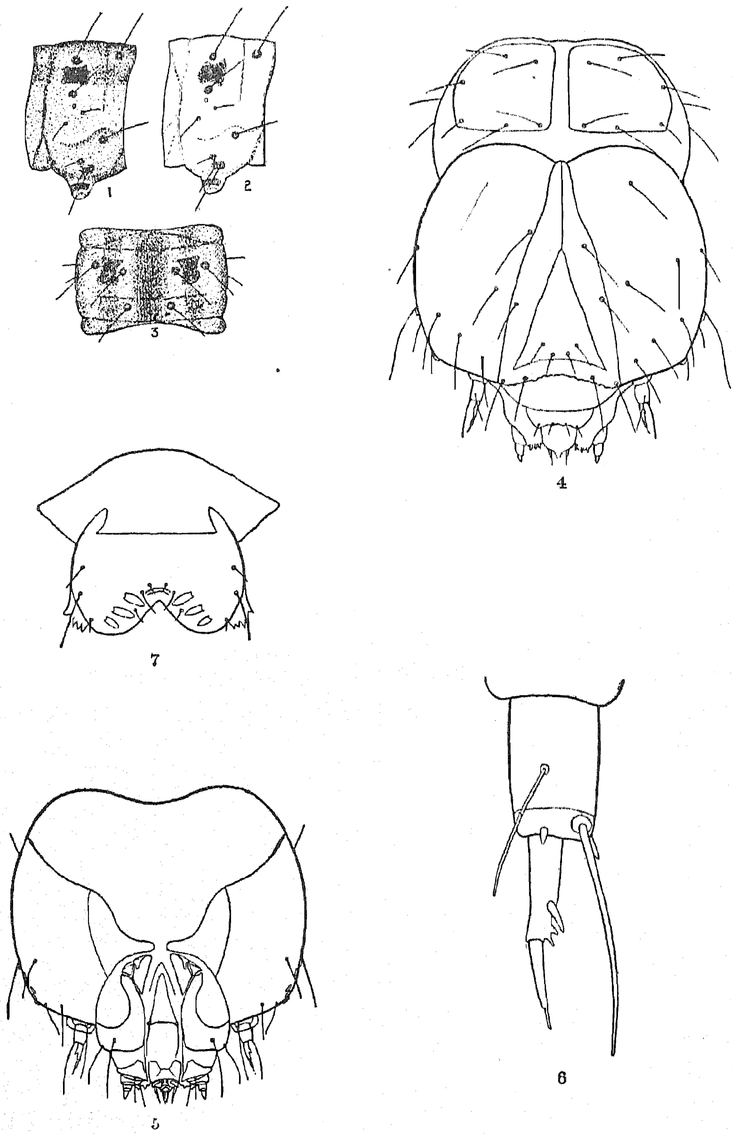
shield, anal plate and legs dark; body pale, but under magnification and with transmitted light it is dirty yellow in color and tuberculose; spiracles brownish, and those commencing with the fourth abdominal segment have above them a pigmented spot, bearing a spine; hairs on dorsum of thorax and abdomen fine and few in number. This description is based on caterpillars in the hibernating stage as taken from the egg mass.

Mature larva.— The general characters of the larva are as follows: Head, thoracic shield and anal plate, black; anterior and posterior extremities much more narrow than remainder of body; head conspicuously notched behind; body pale, light yellow, dirty grey or greenish, sometimes appearing brownish on dorsum; four dark setigerous tubercles on dorsum of segments IV to XI inclusive; sides of segments with two rows of similar tubercles more widely separated; segments II to XI with two large dark, kidney-shaped pigmented areas subdorsally; average length 15 mm. Plate XL.

The following is a detailed description of the full-grown larva, or last instar: Length, 15 mm. average; greatest width 2 mm.; body cylindrical, attenuated at both extremities, especially on posterior part. The segments are outlined by constrictions, and are more or less distinctly divided into three annulets. Pile is very fine and visible only when magnified, otherwise the body appears naked except for a few fine, slender setæ that project from minute, almost obscure, tubercles; feet black and equal; prolegs rather short, with a semi-circular brown band on outer face of each foot; crochets three rows deep in a circle; anal plate black and of small size; anal-leg plate brown on dorsal and median portion and black on ventral side. Spiracles are small, slightly elliptical, that of segment XII being the largest.

Head black, smooth, inclined to oblate in shape, conspicuously incised on posterior margin, sparsely covered with light-colored hairs; antennæ small; antennæ, epistoma and labrum brown; tips of mandibles dark or blackish brown; clypeus of medium height, acutely triangular, its lateral margins sinuate, and near its base four setæ arranged in an inverted arch; paraclypeal pieces long, narrowing toward bases, with two spines one above the other near apex of clypeus; ocelli six in number, with or without pigmentation, the group being protected by setæ.

Cervical shield black, divided on median or deeply incised on posterior margin, with six fine, dark setæ arranged in rows of three on each lateral one-half of shield,— one row parallel to anterior margin and one row parallel to posterior margin; laterad of the shield, cephalad of spiracle, a small black pigmented area with three setæ of which the central one is longest; directly laterad two setæ from a small black pigmented area; spiracle oval and brownish.



Larval Structures.

1 and 3, Lateral and dorsal views of dark form; 2, light form, showing setæ and markings of abdominal segments; 4, setæ on front of head and thoracic shield of caterpillar; 5, rear of head, showing setæ; 6, antenna of caterpillar; 7, labrum of larva.

On segments II to XII a median dorsal and two sub-dorsal shaded areas which appear as three lines or bands. These lines vary in distinctness in different individuals. Each sub-dorsal band is interrupted by a distinct brown or black blotch on the second annulet of the IV to XI segments. The positions of the tubercles on segments V to IX are: — ii slightly dorsal to i, i being situated at the upper border of a sub-dorsal black patch; iii lateral; iv and v remote, iv being out of line with v, slightly below lower border of spiracle; vi posteriorly sub-vented; vii, of the three setæ on base of leg, the upper one not closely approximated to the other two; viii next midventral line. The arrangement of the setæ on segments IV, X, XI is similar to the above except that tubercle vii is represented by two setæ on segments IV and X, and by one seta on segment XI. On segment XII, i, ii, iii and viii are normal, and in the place of tubercles iv, v, vi and vii there are three or four setæ, occurring as pairs with some larvæ and in other specimens as one pair and a single seta. This difference in the number of these setæ was frequently noticed on the right and left sides of the same segment.

Pupa.— The head, wing covers and tip of abdomen usually blackish brown and the remainder of the body yellowish. This coloration seems to be quite constant for the insects reared on hawthorn, but pupæ from caterpillars reared on cherry were yellow or light orange, and dark about head and tip of abdomen. The cremaster consists of six spines, surrounding the anal end. The length is about 9 mm. and the width is 2.5 mm. Plate XL.

Cocoon.— The cocoon is greyish and is from 10 to 12 mm. in length and 3 mm. in width. It is elongated oval in shape, though some specimens are distinctly pointed at one end, giving the cocoon the form of an oat or barley kernel. The cocoons from caterpillars reared on hawthorn are delicate and thin in texture so that the pupa within is generally visible. The cocoons from plum were more compact, and whitish. Plate XLI.

Adult.— Head, palpi and antennæ white. Thorax white with a few black dots. Legs and abdomen white with a silvery sheen. Fore wings snowy white or greyish. The grey coloration is variable in extent and in depth of shade. Frequently the wings are entirely clouded or the grey marking appears as a blotch extending from the costa to the fold or merely as a streak along the outer or costal margin of the wing. The upper sides of the fore wings have usually from twenty to thirty or more dots principally distributed in three rows; one near costal margin and one on each side of the wing fold, with a variable number about the apex. Cilia pale grey or white with greyish tips. The undersides of the wings are grey or brownish grey and cilia grey. The hind wings are ashen-grey or fuscous, with fringe sometimes somewhat paler. Undersides grey, not differing appreciably from the upper surface. Expanse of wings 19 to 22 mm. Plate XLII.

LIFE STAGES OF *malinellus.*

Egg.— This is apparently not distinguishable from that of *padellus.* The egg masses are also of a similar appearance. Plate XXXVIII.

Larva.— The mature caterpillar is apparently not different in its external characters from the *padellus* larva. The caterpillars reared on apple seedlings varied much in coloration, and the majority of them were yellow and lacked the median dorsal and sub-dorsal shaded areas which usually prevailed with the preceding species. Plates XXXIX and XL

Pupa.— Light orange yellow or brown, with the extremities sometimes dark. Length, 6–8 mm. Plate XL.

Cocoon.— White and more densely woven than with preceding form. Cocoons are thickly massed in the tent. Plate XLI.

Adult.— Similar to the light form of *padellus* and indistinguishable from it. Plates XLI and XLII.

LIFE HISTORY AND HABITS.

Oviposition occurs principally during the latter part of June or during July, according to latitude and seasonal conditions, and hatching takes place in early autumn. The young larvæ at this season are inactive and remain sheltered through the winter under the protecting crust of the eggs. They abandon their winter quarters as the first leaves begin to unfold in the spring, making their exit through one of several tiny holes in the covering of the egg mass. The young caterpillars assemble among the tender leaflets of an adjacent bud and those of *malinellus* on apple bore into the parenchyma, beginning at the edge and usually near the apex of the leaf. As many as a dozen of the insects may exist as a colony within the pulpy substance of a single leaf. Within a few days after their entrance the leaves turn reddish at the points of injury, and those more severely mined may wither and die. Towards the end of the time of blossoming the caterpillars cease to burrow and feed openly on the leaves, concealing themselves with a greyish web. With the need of more food they extend their webs, seizing and involving fresh leaves in the common nest, on which they feed. Having destroyed the foliage on one branch they migrate "en masse" to another, and in severe attacks the trees may be defoliated and completely covered with a veiling, which becomes discolored by stains from the enclosed fragments of leaves and the dust-like excremental particles of the insects. On reaching maturity the larvæ spin their cocoons in contact with each other and, according to Mokshetsky, there may be during very destructive outbreaks as many as fifteen hundred cocoons placed side by side in regular rows within the silken tent. The moths make their appearance during the latter part of June or early July, and egg-laying commences

in about fifteen days after their emergence. The adults are motionless during the daytime, but with the approach of night they fly gently for short distances in a zig-zag course. The larvæ of *padellus* apparently do not have the mining habit; but, aside from the fact that they do not burrow into the leaves of their favorite host plants, as hawthorn, plum, etc., the life history and habits of this insect are similar to those of the above moth.

OCCURRENCE OF ERMINE MOTHS IN NEW YORK.

THE DISCOVERY.

The discovery of *padellus* in the State of New York was due to the close supervision of foreign importations of nursery stock during the spring of 1909 by the agents of the Division of Nursery Inspection of the New York Department of Agriculture. Special precautions were observed this year with such stock, which have since been followed, because many nests of the notorious "brown-tail moth" (*Euproctis chrysorrhœa* L.) were detected among the shipments, a source of danger from this insect which was not fully appreciated until this experience. After the setting out of the plants, the plantations were frequently examined for the appearance of destructive insects. Nothing was noted to arouse any suspicion until June 23 when Mr. John Maney, an official nursery inspector, detected three cherry seedlings completely covered with webs. The unfamiliar appearance of the nests and the enclosed caterpillars, coupled with the fact that the specimens were taken from foreign nursery stock, influenced him to bring the material to the Department of Entomology of this Station for identification. The plantation from which the insects were obtained was inspected again several times, and on June 24 five more infested cherry seedlings were secured. Examinations were made a little later in this and other similar plantings in different parts of the State to find more specimens of the caterpillars or traces of the insect but without success.

IDENTIFICATION OF SPECIES.

Nearly all the material collected during 1909 was immediately destroyed to avoid taking chances on the escape of any of the insects. Some caterpillars, however, were reared in the laboratory to obtain a few adults in order that the species should be correctly determined. Six moths were obtained, which were compared with descriptions by various authorities, and the insect was identified as *Yponomeuta padellus* L. A statement to that effect was published in a technical periodical.[1] To make certain the identity of the species which we

[1] *Jour. Econ. Ent.*, 2: 305. 1909.

had bred, several specimens of the moths were later sent to Dr. Paul Marchal of Paris, France, who has devoted considerable study to these insects and his report was a confirmation of our identification.

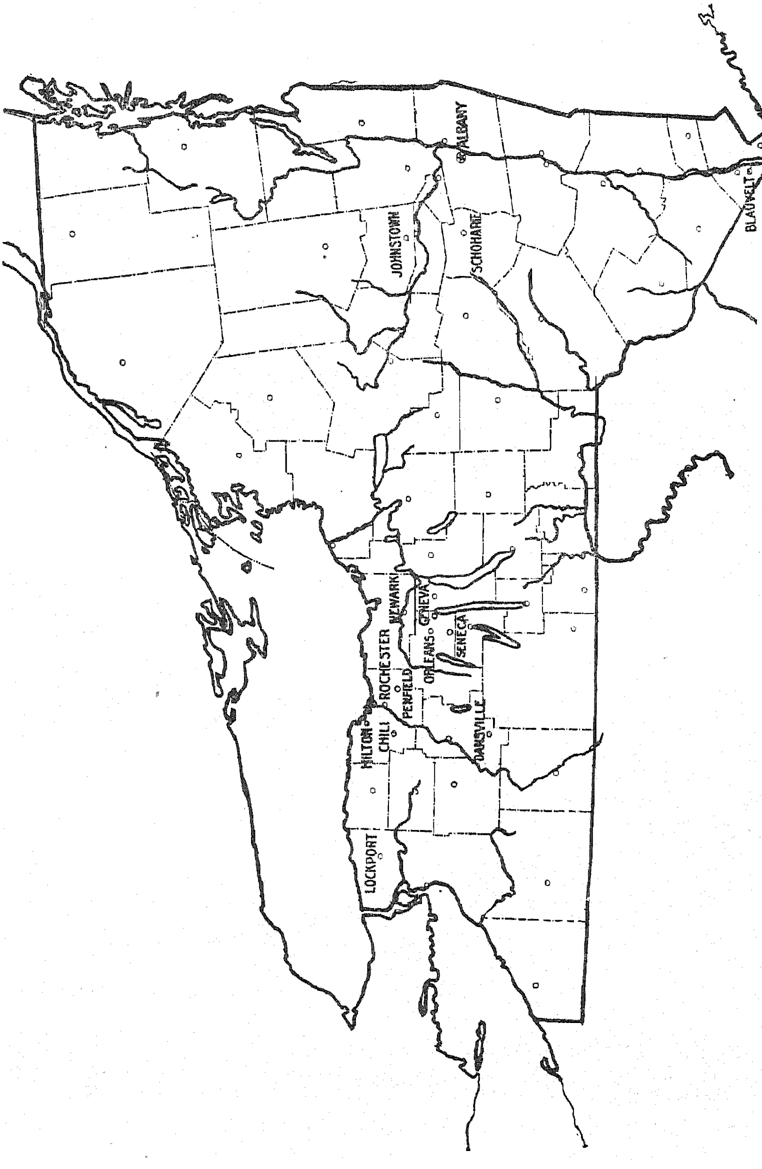
IMPORTATIONS FROM 1910 TO 1912.

During the spring of 1910 the local importations of foreign seedlings were very large. The same conditions prevailed with regard to the brown-tail moth, although the winter nests of this species were much less numerous than during the previous year. All stocks were carefully examined for evidences of other injurious insects and the usual precautionary measures were taken as before under the direction of the Division of Nursery Inspection. The local nurseries were carefully watched during June for the appearance of *Yponomeuta* caterpillars, and on the 24th of this month colonies of the insects were found on apple seedlings. Mr. G. G. Atwood, Chief of the Division of Nursery Inspection, was promptly notified of the discovery and instructions were at once sent to the inspectors in the field to make an immediate and careful canvass of all plantings of nursery stock set out during 1909 and 1910. During the following two weeks infestations were discovered in other plantings about Geneva and in nurseries about Orleans, Newark, Hilton, Schoharie, Blauvelt and Dansville; and from these, eight hundred and seventy-three colonies of caterpillars were obtained.

The plantings of foreign seedlings during 1911 were noticeably much more free of *Yponomeuta* nests than during the two preceding years. On June 8 a single nest of about fifty caterpillars was obtained at Lockport, and during the latter part of this month and early July a few infested plants were found about Geneva, Penfield, Chili, Johnstown and Schoharie. At the last-named locality empty cocoons of the insect were discovered which indicated that the caterpillars had pupated and the moths had made their emergence.

During 1912 the nests and caterpillars obtained were less in number than in any year since our attention has been called to the occurrence of these pests in this State. Infested seedlings were first detected at Seneca and later colonies of the insects were found in nursery plantings about Geneva and Rochester.

The following table showing the collections of colonies of the ermine moths in this State during these years is based on data which was kindly furnished by Mr. G. G. Atwood through the courtesy of Calvin J. Huson, Commissioner of Agriculture of the State of New York.



MAP 1.—LOCALITIES IN WHICH IMPORTED SEEDLINGS HAVE BEEN FOUND, INFESTED WITH ERMINE MOTHS.

TABLE 1.—ERMINE MOTHS COLLECTED IN NEW YORK DURING THE YEARS 1909–12.

Date.	Name of inspector.	Number of seedlings with nests	Kind of seedling.	Locality.
June 23, 1909	John A. Maney	3	Cherry	Geneva.
24, 1909	John A. Maney	5	Cherry	Geneva.
24, 1910	John A. Maney	6	Apple	Geneva.
25, 1910	John A. Maney	62	Apple	Geneva.
26, 1910	John A. Maney	110	Apple	Geneva.
27, 1910	J. J. Barden	10	Apple	Orleans.
28, 1910	James Goold	1	Apple	Schoharie.
28, 1910	P. L. Huested	8	Apple	Blauvelt.
28, 1910 to July 5, 1910	J. J. Barden	663	Apple	Orleans. Newark. Dansville.
June 29, 1910	James Goold	2	Apple	Schoharie.
30, 1910	John A. Maney	2	Apple	Geneva.
July 1, 1910	John A. Maney	8	Apple	Geneva.
5, 1910	J. A. Thompson	[1] 1	Apple	Hilton.
June 8, 1911	Bernard Blanch	[2] 1	Apple	Lockport.
19, 1911	J. A. Thompson	2	Apple	Penfield.
22, 1911	John A. Maney	5	Apple	Geneva.
28, 1911	J. A. Thompson	4	Apple	Chili.
July 6, 1911	James Goold	[3] 2	Apple	Schoharie.
7, 1911	James Goold	1	Cherry	Johnstown.
7, 1911	James Goold	2	Apple	Johnstown.
June 12, 1912	Bernard Blanch	[4] 1	Apple	Seneca.
19, 1912	Charles Darrow	[5] 3	Apple	Seneca.
25, 1912	J. A. Thompson	[6] 2	Apple	Rochester.
28, 1912	John A. Maney	[7] 1	Apple	Geneva.

[1] The nest at the time of delivery to the Station had five pupæ.
[2] This nest was reported as having about 50 caterpillars.
[3] On this date cocoons were formed and moths had escaped.
[4] This nest contained 3 caterpillars.
[5] Three, 14 and 36 caterpillars respectively.
[6] Nine and 16 caterpillars respectively.
[7] Five caterpillars.

NOTES ON IDENTITY OF APPLE SPECIES.

CHARACTERS FOR SEPARATION OF SPECIES.

The determination of the moth bred from cherry as *padellus* has already been mentioned, and it is now to be noted in Table I that by far the larger number of *Yponomeuta* larvæ were collected from apples. The question arises, " To which species do these belong,— to *padellus* or *malinellus?* The moths of the former, as has been previously indicated, are exceedingly variable in their markings, and unfortunately the identification of the two species seems to rest largely upon color distinction of the adult insects. In spite

of seeming morphological and biologic differences the separation of these insects is difficult and unsatisfactory, and there exists consequently considerable uncertainty as to the actual status of these two forms.

According to Dr. Marchal [1] "the ground color of the front wings is entirely white with *malinellus*, and more or less tinted with grey with *padellus*. The fringe of the anterior wings, examined from below, is whitish for the most part with *malinellus*, while with *padellus* it is grey or almost entirely grey. Finally the undersurfaces of the front wings of *padellus* are entirely grey, while the margins of the wings of *malinellus*, examined from below, are finely bordered with white. . . . . . . *padellus* is extremely variable, and the variation extends to the characters which are used to distinguish it from *malinellus*. Certain examples have the anterior wings largely tinted with grey, others have white wings, while some are intermediate. The fringes are also variable in their coloration, and the narrow white border of the lower surface is not always a constant character."

Some apparent differences in feeding habits and appearances of the caterpillars, and in the coloration of the pupæ and texture of the cocoons have also been noted. Lewis [2] in 1836 called attention to the fact that the larvæ of the *Yponomeuta* on apple upon emerging from the egg masses in the spring are leaf miners. This was verified by Delacour [3] in 1850 and Bissière [4] in 1876 and while this habit has been overlooked by many writers it has been described with much detail by Mokshetsky in his recent treatise. Marchal also records that *mahalebellus*,[5] a closely related species, similarly burrows into the leaves of the Mahaleb cherry. Curiously enough the mining instinct which manifests itself with the foregoing species has apparently not been observed or at least satisfactorily established for *padellus* caterpillars. Rebaté and Bernès also call attention to apparent preferences for host plants which, coupled with slight differences in the appearance of the moths, larvæ and pupæ are given by them to support the opinion that the insects represent distinct species. According to them branches of plums and apples may intercross, and, depending on which of the two forms is present one fruit will have the foliage eaten while the other will be immune. Moreover in some experiments conducted by them the larvæ of *padellus*, reared on plum, would not attack apple foliage; and vice versa caterpillars of *malinellus* taken from apple would not feed on plum. To the contrary Gruvel [6] states that in a test conducted

[1] *Bul. Soc. d'Étud. et Vulg. Zool. Agric.* p. 23, 1902.
[2] *Trans. Ent. Soc. London* 1:21–22, 1836.
[3] Essai sur les Insectes, 1850, p. 296.
[4] *Bul. d' Insectologie Agricole*, No. 4, p. 83, 1876.
[5] *Bul. Soc. d'Étud. Vulg. Zool. Agric.*, p. 21, 1902.
[6] Quoted from La Chenille Fileuse, Rebaté and Bernès.

by him young larvæ of *malinellus* taken from apple subsisted equally well on plum foliage and mined the leaves, as is their normal habit on their favorite host. The opinion of Schöyen that *padellus* is the common species on apples in Norway and the observation by Bos of *padellus* migrating from Cratægus to apple trees have already been mentioned.

The differences noted by Rebaté in the appearances of the larvæ and cocoons of *padellus* as reared on plums in comparison with these stages of *malinellus* bred on apple are as follows: — The caterpillar of the former species is of a yellowish-grey color. The cocoons are thin in texture, of a greyish-white color and more or less detached from one another in the tent, while the caterpillars of the latter species are lighter in color and a little shorter and more slender. The cocoons are white, more dense and compact, and are attached one to another forming clusters or packets which vary in size according to the numbers of the caterpillars in the colony. Theobald observes similar differences in the cocoons and adds that the nest or tent is likewise not nearly as compact with *padellus* as with the apple-feeding species.

COMPARISONS OF COLLECTIONS OF *padellus* AND *malinellus*.

Bearing in mind the foregoing distinctions it is now of interest to compare collections of these insects from various geographical areas to note the range of variation and the forms that are in the region of their occurrence understood as constituting *padellus* and *malinellus* respectively. There is also included in this comparison the material bred from apple and cherry in New York.

Padellus.	*Malinellus.*
Habitat,[1] Germany. Host plant, hawthorn. Moth, primaries, including fringe, clouded and dark. Expanse of wings 22 to 23 mm.	Habitat,[2] Germany. Host plant, apple. Moth, primaries entirely white or white with exception of fringe which may be slightly clouded. Expanse of wings 19 to 20 mm.
Larva, dark olive-green with dorsal spots rather indistinct. Length 15 to 17 mm.	Larva, pale, dirty white or greenish-yellow with dorsal spots distinct. Length 10 to 12 mm.
Pupa, head, wing pads and tip of abdomen dark brown or black and remainder of body yellow. Length 7 to 9 mm.	Pupa, pale or brown. Length 6 to 8 mm.
Cocoon, greyish-white, thin and pupa visible.	Cocoon, white, densely woven, and concealing pupa.
Habitat,[3] France. Host plant, hawthorn.	Habitat,[4] France. Host plant, apple.

[1] Collection, 2 adults, 3 larvæ and 12 pupæ from Dr. L. Reh, Hamburg, Germany.
[2] Collection, 7 adults, 3 larvæ and 4 pupæ from Dr. L. Reh, Hamburg, Germany.
[3] Collection, 2 adults, 4 larvæ and 3 pupæ from M. J. de Joannis, Paris, France.
[4] Collection, 17 adults, 3 larvæ and 5 pupæ from M. J. de Joannis, Paris, France.

Padellus.

Moth, primaries clouded, with apex and fringe noticeably darker. Expanse of wings 17 to 18 mm.

Larva, dirty-white, greenish-yellow, or olive green, dorsal spots distinct with light forms. Length 12 to 16 mm.

Pupa, head, wing pads and tip of abdomen dark brown or black; remainder of body yellow. Length 8 to 9 mm.

Habitat,[2] Scotland.
Host plant, apple.
Moth, primaries white, expanse of wings 16 to 20 mm.
Larva, pale with conspicuous dorsal spots or dark olive-green with markings less distinct. Length 10 to 12 mm.
Pupa, pale to yellowish with extremities brownish. Length 6 to 8 mm.
Cocoon, white and of dense texture concealing enclosed pupa, in compact clusters.

Habitat,[3] Holland.
Host plant, hawthorn.
Moth, primaries generally dark showing cloudy or lead-colored areas about fringe or costal margin. Few specimens almost white. Compared with moths reared on apple this collection appears on the whole quite dark. Expanse of wings 21 to 22 mm.
Larva, pale to dark olive green. Length 15 to 17 mm.
Pupa, head, wing pads and tip of abdomen black; remainder of body yellow. Length 7 to 10 mm.
Cocoon, greyish white and of thin texture showing the pupa.

Malinellus.

Moth, primaries usually entirely white, but quite a few specimens have fringe slightly shaded. Two specimens have a very distinct grey fringe and a dark blotch along costal margin. Expanse of wings 16 to 22 mm.

Larva, pale, and dorsal spots distinct or dark olive in color with dorsal markings less conspicuous. Length 11 to 15 mm.

Pupa, light orange yellow with head and tip of abdomen dark brown or blackish. Length 7 to 10 mm.

Habitat,[1] Hungary.
Host plant, apple.
Moth, primaries white with only an occasional specimen with clouded apex or fringe. Expanse of wings 18 to 20 mm.
Larva, pale and dorsal spots prominent. Length 15 to 16 mm.
Cocoon, white, dense and thickly massed.

[1] Collection, 31 adults, 3 larvæ and 10 cocoons from F. A. Cerva, Szigetcsep, Hungary.
[2] Collection, 7 adults, 10 larvæ and 3 pupæ from Prof. R. Stewart MacDougall, Edinburgh, Scotland.
[3] Collection, 20 adults, 3 larvæ and 8 pupæ from Prof. J. Ritzema Bos, Wageningen, Holland.

Padellus.	*Malinellus.*
	Habitat,[1] Japan. Host plant, apple. Moth, primaries including fringe usually white, but fringe is sometimes slightly clouded. One moth also shows shading on costal margin. Expanse of wings 20 to 22 mm. Larva, dark olive green. Length 12 to 15 mm. Pupa, head, wing pads and tip of abdomen dark brown, and about constrictions of abdominal segments lighter brown. Length 10 to 12 mm. Cocoon somewhat thin in texture, greyish or white in color, and thickly massed.
Habitat,[2] New York. Host plant, Mahaleb cherry. Moth, primaries white with fringe slightly clouded. Expanse of wings 18 to 19 mm. Larva, pale or greenish-yellow or olive green. Length 12 to 16 mm. Pupa, light orange yellow and dark brown or black about head and tip of abdomen. Length 8 to 9 mm. Cocoon, white and concealing pupa.	Habitat,[3] New York. Host plant, crab. Moth, primaries white or white with fringe slightly clouded. Expanse of wings 18 to 20 mm. Larva, pale, greyish-brown or dark greenish yellow. Length 12 to 15 mm. Pupa, light orange yellow and some specimens with extremities dark. Length 6 to 8 mm. Cocoon, usually white and densely woven, but some specimens were thin in texture, showing the pupæ.

From the foregoing comparisons it will be observed that the adults of *padellus* from hawthorn and of *malinellus* from apple represent for the most part extremes in wing coloration. The former contains a majority of moths which have the primaries and fringes clouded, greyish or lead colored, while the latter has a majority of moths with primaries and fringes white. The two are distinct enough when characteristic examples are selected, but the separation of them becomes difficult when the intergrading forms are considered, as they merge into each other by imperceptible gradations.

The larvæ of both forms are quite variable in color but they present no structural differences. In the collections from apple seedlings pale forms predominated. The pupæ and cocoons of the insects from hawthorn as shown by Rebaté consistently differ from those taken from apple, but no constant differences were observed in the material collected from cherry in comparison with that obtained from apple. If any differences exist in the insects reared by us from cherry and apple they are principally that the moths

[1] Collection, 14 adults, 15 larvæ and 3 pupæ from Dr. S. I. Kuwana, Tokio, Japan.

[2] Collection, 6 adults, 12 larvæ and 2 pupæ from imported seedling cherries growing in nursery plantations about Geneva.

[3] Collection, 76 adults, 16 larvæ, 7 pupæ from imported apple seedlings growing in nursery plantations about Geneva.

reared from cherry invariably had shaded areas along the outer margins of the wings, while those from apple had for the most part white primaries.

Taking all characters into consideration, the prevailing white anterior wings of the adults, habits of larvæ, coloration of pupæ, texture and massing of cocoons in the web, the species we have reared on apple seems unquestionably to be identical with the form commonly known in Europe as *malinellus*.

CROSS-FEEDING EXPERIMENTS.

The contradictory results obtained by various writers in feeding tests with *padellus* and *malinellus* by interchanging their host plants led us to make some tests along similar lines. Three small sections of wood, each containing a colony of *padellus* larvæ, were, at about the period for their migration from the egg masses, placed near opening apple buds and slightly moistened each day to prevent drying. None of the larvæ emerged and all eventually died. Later living larvæ were taken from their hibernating quarters on cherry and transferred to apple buds which were just showing the tips of the first leaves. These apparently did no feeding, nor did they make any efforts to burrow into the apple leaves. After struggling for several days on the surfaces of the leaves and frequently precipitating themselves to the ground, they finally succumbed. Their efforts were feeble as if they had suffered from the handling and confinement during storage of the nursery stock or the conditions incidental to their removal or opening of their hibernating quarters were abnormal and injurious to them.

Tests with older caterpillars of *malinellus* were more satisfactory. Twenty full-grown specimens of *malinellus*, reared on imported apple seedlings, were placed in a cage containing twigs from Baldwin apple and Montmorency cherry. Webs were at once spun over both fruits but the insects fed only on the apple and apparently made no effort to attack the cherry. This experiment was repeated with a similar number of insects, but only a single twig of apple was used which was placed in the center of a number of shoots of Montmorency cherry. The caterpillars quickly selected the apple twig and after consuming the apple leaves they extended their webs over the cherry foliage but in no case did they feed upon it.

A third test was then made with thirty caterpillars which were confined to a young Mahaleb cherry seedling. They were at first very restless and seemed to exhibit an aversion for the foliage; but later this was overcome and apparently under the stress of hunger several were observed to eat the leaves with relish. Most of the insects, however, fed very little. Twigs of an imported apple seedling were then introduced into the cage which were attacked in a ravenous manner. In spite of an abundance of apple foliage a caterpillar was occasionally observed nibbling on cherry leaves.

COMPARISONS OF GENITALIA.

With these moths the uncus is long and slender, and it is sinuate towards the tip which is acute and a little hooked. The lateral pieces or claspers are broad and hemispherical, with the apices gently rounded or somewhat acutely rounded according to their positions in the mounts. The sexual parts of the male are symmetrical or very closely so, and the general type of the genitalia of this group of moths is shown in Plate XLIII.

A study of a goodly series of mounts of *padellus* from hawthorn and *malinellus* from apple from different geographical areas reveal no tangible structural differences between them. The lobe or spur at the base of the uncus varies slightly in width and length with some individuals, but this variation may also be detected with any assemblage of males from either of these hosts. A comparison of the figures, Plate XLIII, plainly shows that there are no obvious distinctions in the more important organs which will bear out these minor differences.

Considering all differential features, structural as well as superficial, it appears that the moths of *malinellus* do not possess sufficiently diverse values to entitle them to specific distinction and that the specimens bred from hawthorn, cherry and apple really constitute a single species. Breeding experiments are now needed to definitely settle the status of these two moths, and these we have not undertaken as it did not seem wise to take chances with the insects. We have, therefore, followed the example of European writers, and have treated the two forms as distinct species.

THE ERMINE MOTHS ON SEEDLINGS.

ORIGIN OF INFESTATION.

The stock which has been responsible for the introduction of the ermine moths consists of one-year-old seedlings, which are frequently grown in plats near hedge rows, trees or even woodland. Such surroundings are very favorable for the breeding of various destructive pests. The flight of the ermine moths takes place during July and August, and in their excursions some of them have unquestionably made their way to the nursery blocks in the immediate vicinity and deposited their eggs on the young seedlings, which were subsequently shipped to the United States. The life history of the insect would indicate this course of events, and since we have become familiar with their appearance we have collected the egg masses on the stocks after their shipment to this country. The conditions during 1909 with respect to these pests surrounding some of the foreign nurseries which have been growing seedlings

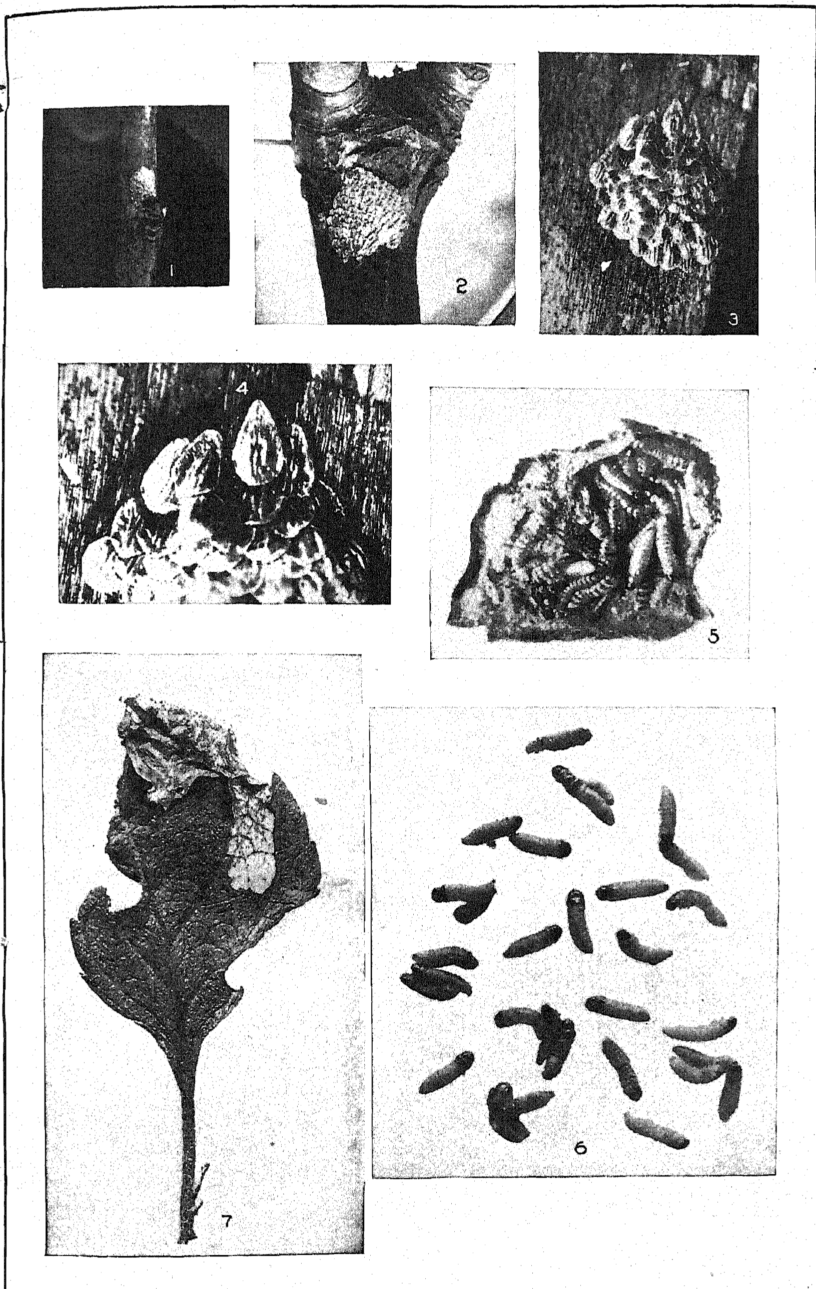


Plate XXXVIII.—Life Stages of *Yponomeuta malinellus*.

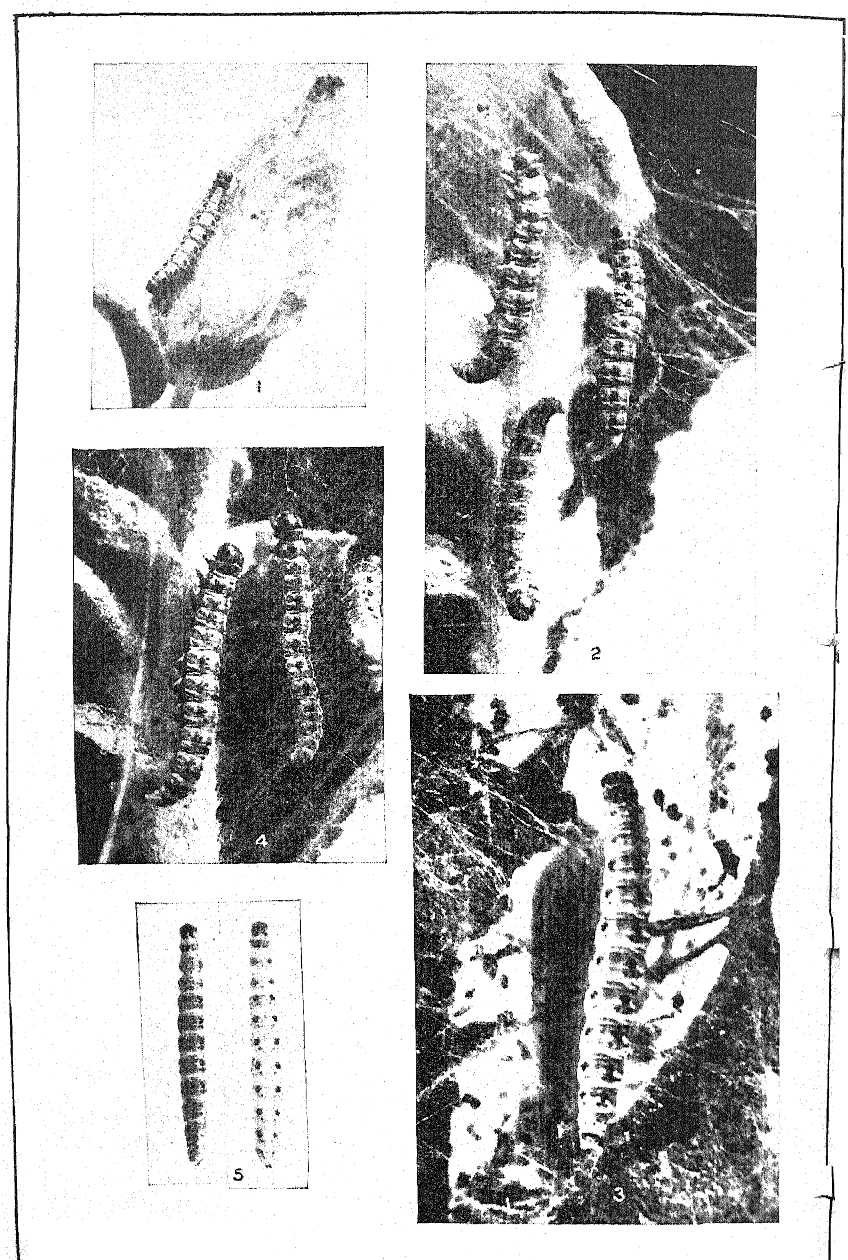


Plate XXXIX.—Caterpillars of *Yponomeuta malinellus*.
(See reverse of Plate XLVI.)

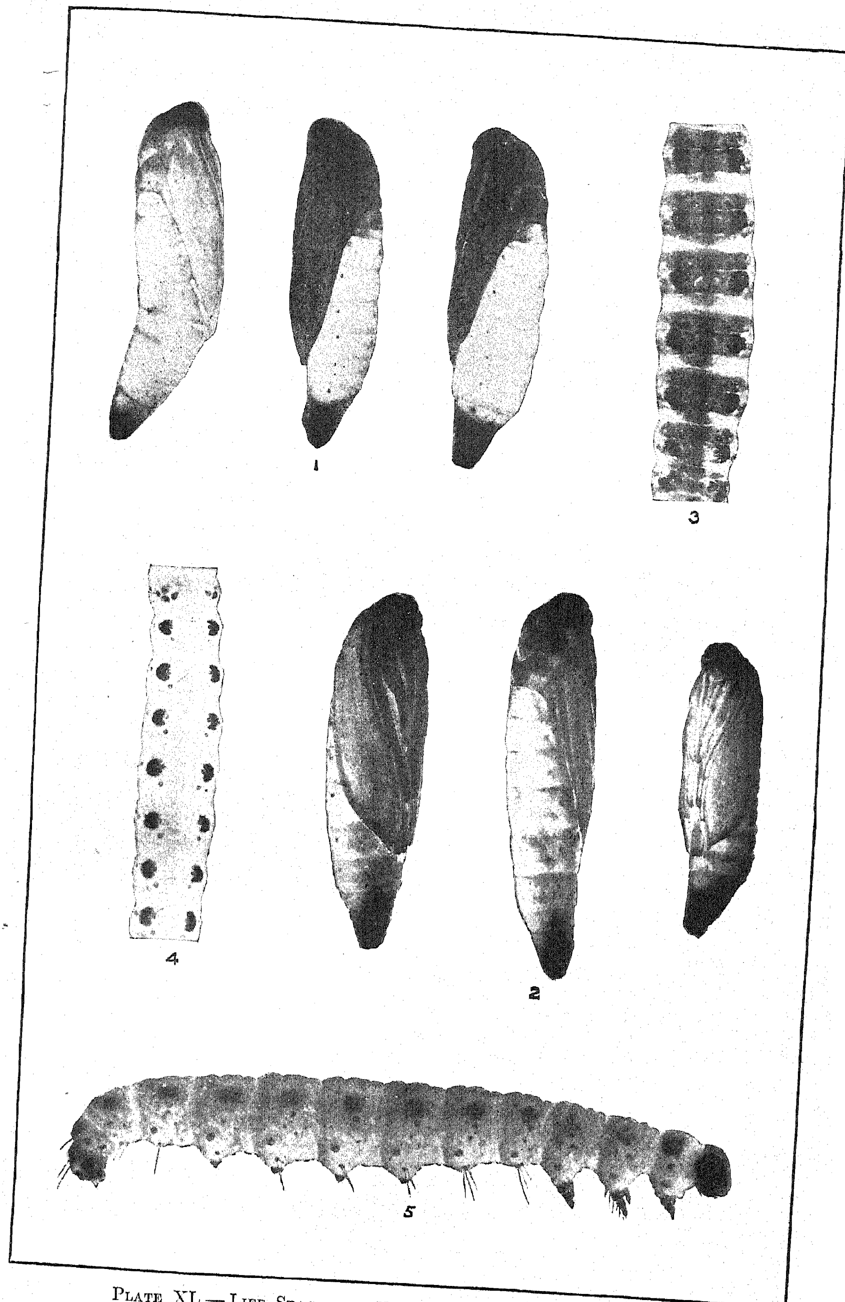


PLATE XL.—LIFE STAGES OF *Yponomeuta padellus* AND *malinellus*
(See reverse of Plate XLVI.)

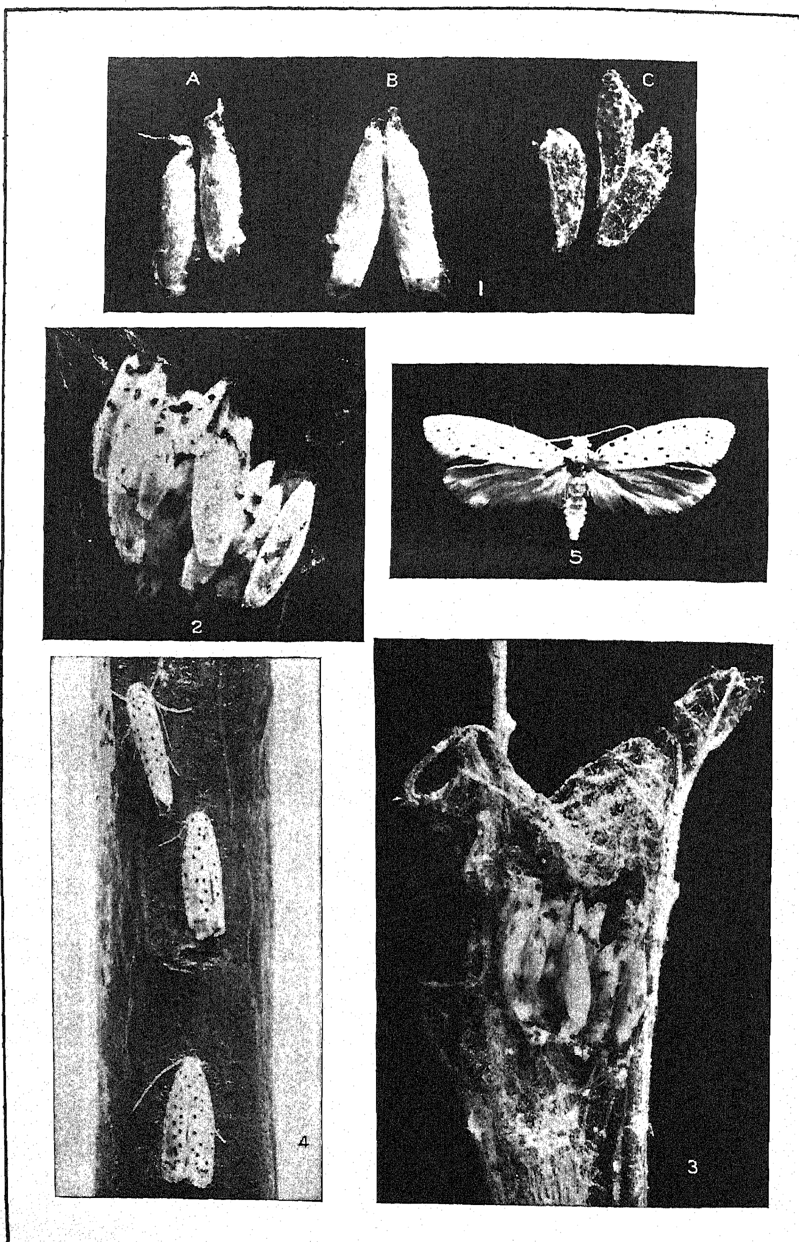


Plate XLI.—Life Stages of *Yponomeuta padellus* and *malinellus*.
(See reverse of Plate XLVI.)

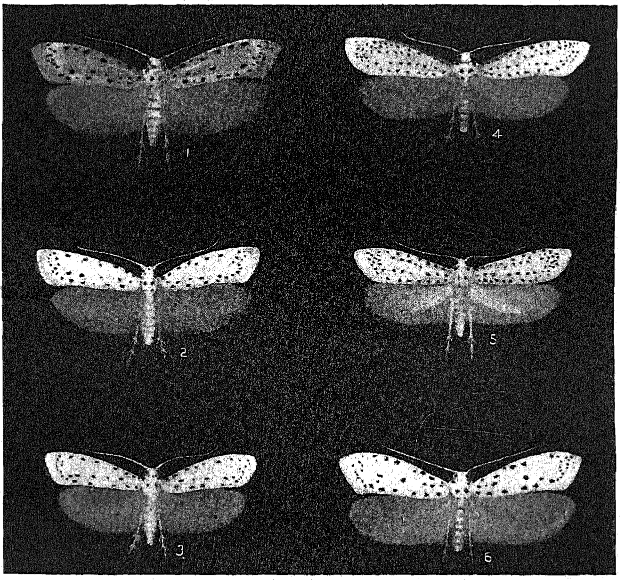


PLATE XLII.— SOME YPONOMEUTA MOTHS.
(See reverse of Plate XLVI.)

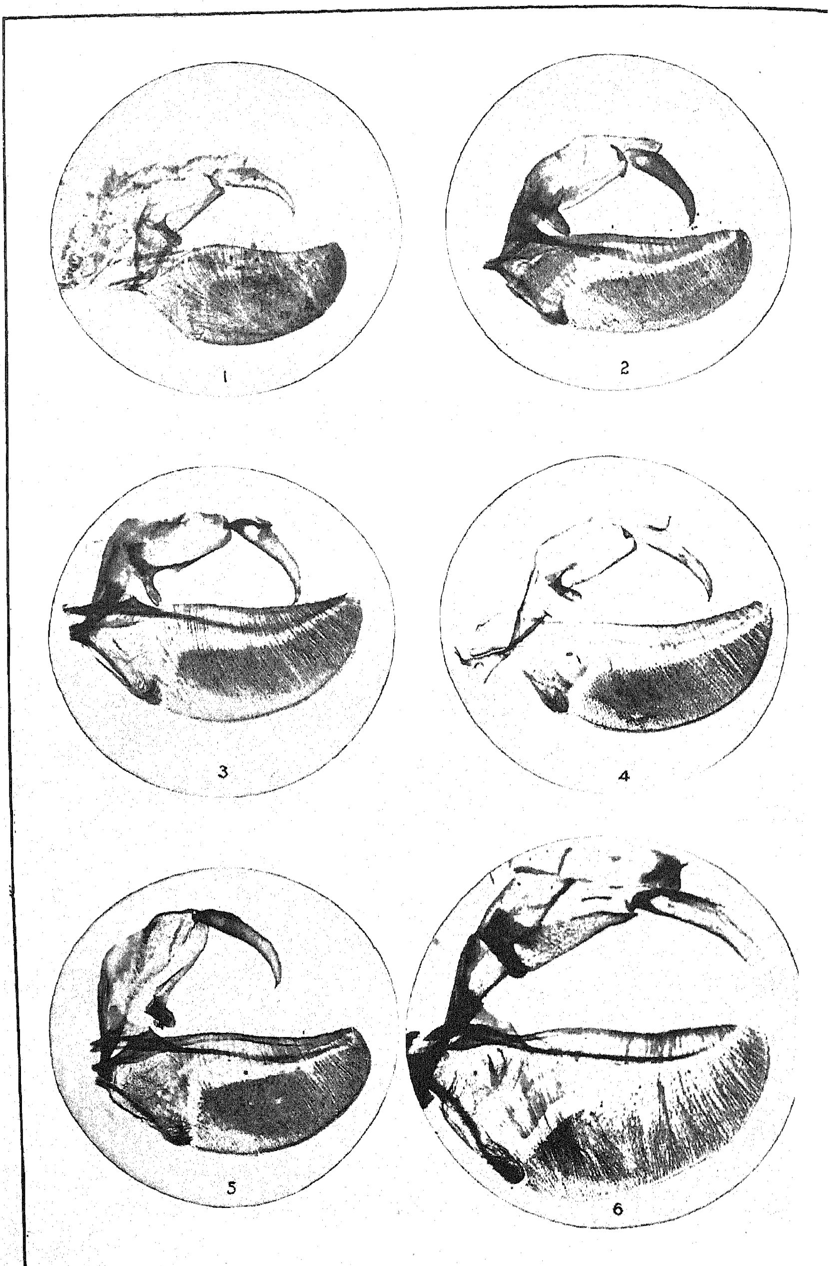


PLATE XLIII.—STUDIES ON GENITALIA OF YPONOMEUTA MOTHS.
(See reverse of Plate XLVI.)

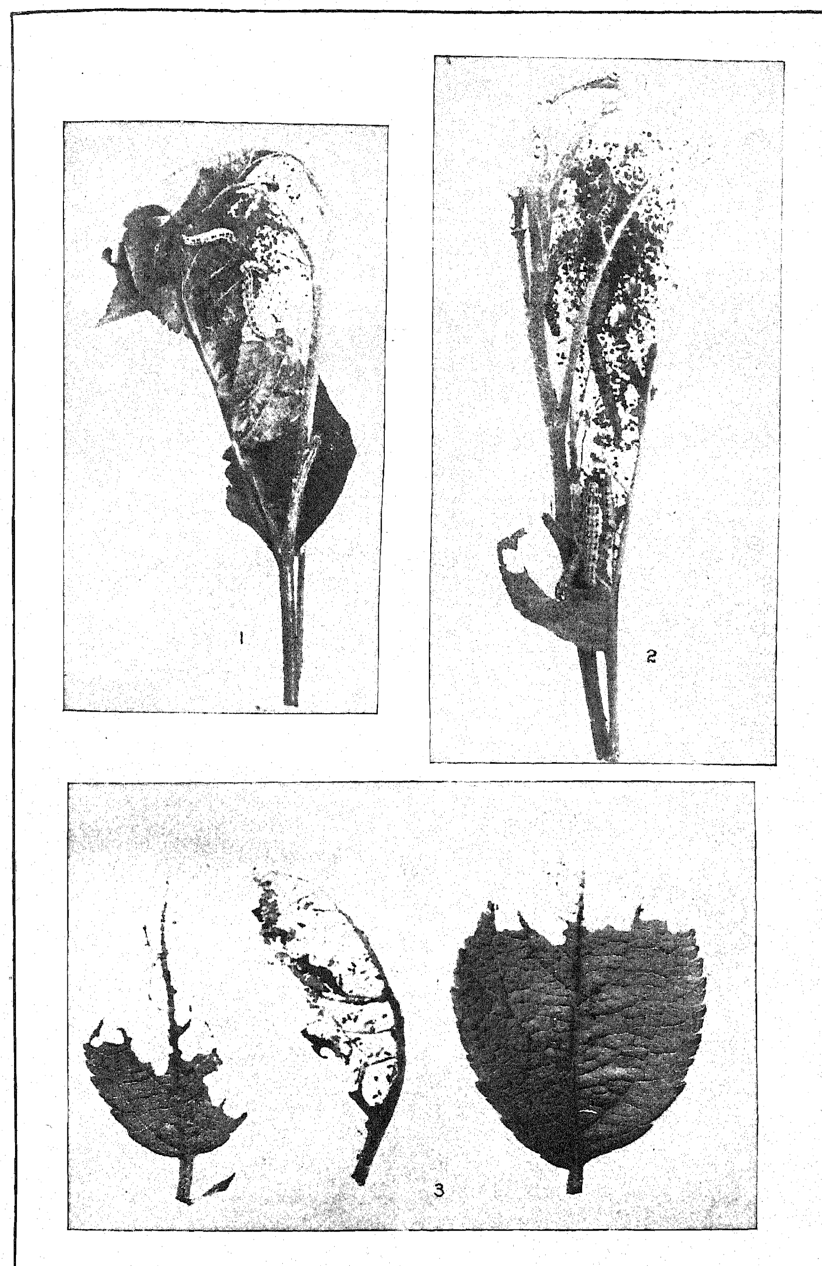


PLATE XLIV.—FEEDING HABITS OF *Yponomeuta malinellus* ON APPLE.
(See reverse of Plate XLVI.)

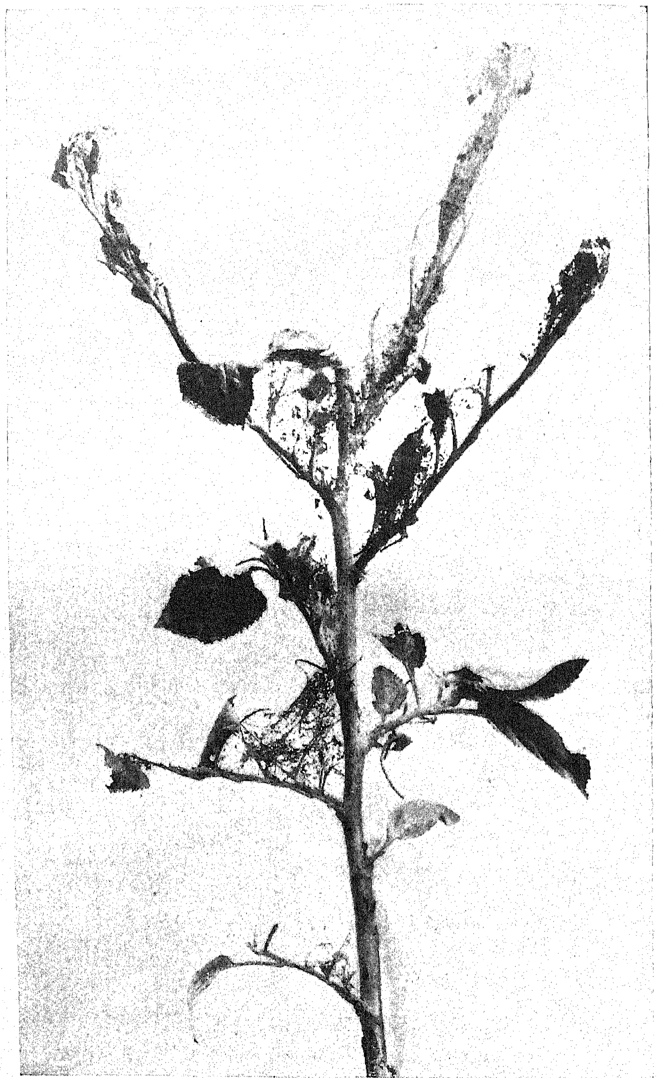


PLATE XLV.—APPLE SEEDLING SHOWING DEFOLIATION AND WEBS OF *Yponomeuta malinellus.*

Plate XLVI.—Cherry Seedling Showing Webs of *Yponomeuta padellus*.

EXPLANATION OF PLATES.

PLATE XXXVIII.— LIFE STAGES OF *Yponomeuta malinellus.*

1, 2, 3, and 4, egg clusters, natural size and enlarged; 5, egg mass reversed showing hibernating larvæ; 6, larvæ enlarged; 7, apple leaf showing "mined" areas.

PLATE XXXIX.— CATERPILLARS OF *Yponomeuta malinellus.*

Characteristic positions on leaves and in webs, and range of variability in color and markings.

PLATE XL.— LIFE STAGES OF *Yponomeuta padellus* AND *malinellus.*

1, Pupæ of *padellus*, and 2, of *malinellus*; 3 and 4, dorsal views of dark and light-colored caterpillars; 5, caterpillar, lateral view showing characteristic markings.

PLATE XLI.— LIFE STAGES OF *Yponomeuta padellus* AND *malinellus.*

1 a and c, cocoons of *padellus* on cherry and hawthorn; 1 b, cocoons of *malinellus* on apple; 2 and 3, cocoons of *malinellus* (enlarged) and position on infested seedling; 4, *malinellus* moths in resting positions; 5, moth enlarged.

PLATE XLII.— SOME YPONOMEUTA MOTHS.

1,. *Yponomeuta padellus* L.; 2, intergrading form of *padellus* and *malinellus*; 3, *Y. malinellus* ZELL.; 4, *Y. evonymellus* L.; 5, *Y. multipunctellus* CLEM.; 6, *Y. mahalebellus* GN. (Enlarged.)

PLATE XLIII.— STUDIES ON GENITALIA OF YPONOMEUTA MOTHS.

1, *Yponomeuta padellus* from hawthorn; 2, *Y. padellus* (*malinellus*) from apple, Scotland; 3, *Y. padellus* from cherry, Geneva, N. Y.; 4, *Y. malinellus* from apple, Japan; and 5, *Y. malinellus*, apple, Geneva; 6, *Y. polystica* (Sent by Kuwana).

PLATE XLIV.— FEEDING HABITS OF *Yponomeuta malinellus* ON APPLE.

1, Spinning of web preparatory to feeding; 2, foliage consumed; 3, character of feeding on apple leaves.

PLATE XLV.— APPLE SEEDLINGS SHOWING DEFOLIATION AND WEBS OF *Yponomeuta malinellus.*

PLATE XLVI.— CHERRY SEEDLING SHOWING WEBS OF *Yponomeuta padellus.*

for purposes of exportation are indicated by Dr. L. O. Howard in the following communication:[1]

"I saw them (*Yponomeuta* spp.) everywhere on my recent trip in France, and especially upon the hedges and trees at the borders of the plats of seedlings being grown for exportation to America. I saw *Yponomeuta* larvæ in their webs on almost every apple tree, sometimes only here and there a twig with some leaves webbed together, and occasionally considerable numbers of these webs." During years favorable for the multiplication of these insects, the chance of nursery stock becoming infested when grown under such circumstances is obviously very great, as has been well demonstrated.

FEEDING HABITS OF THE CATERPILLAR.

Before transplanting in the nurseries the seedlings are stubbed, making a plant which, including the root, measures from fifteen to eighteen inches in length, while the stalk has a diameter of about one-quarter of an inch and bears from five to ten leaf buds. The egg masses of the insects are generally found on the stalk within six to nine inches of the ground, and from one to three egg masses have been detected on a plant. These were placed just under or above a leaf bud, almost touching it, or in positions intermediate between two buds. Opportunity has not been afforded to observe the early movements of the larvæ but, judging from the conditions of leaf clusters, it would appear that the young caterpillars on emerging from the egg mass preferred the nearest opened bud above them, while dormant buds were passed by unharmed. Our observations indicated that the caterpillars on apple seedlings were, at this stage, leaf miners. The first leaves attacked by them showed along the margins near the tips reddish or rusty-colored blotches of varying sizes, and as a result of this injury the leaves were small as if stunted, while others were one-half destroyed or entirely killed. On abandoning their "mines" the caterpillars ascended higher on the seedlings and, on June 12, when first detected, were feeding openly on some of the upper leaf clusters on the central stalk of the plants or at the base of the terminal offshoots which were then from three to four inches in length. They spun a filmy tangle of fine silken threads between two leaves and proceeded to consume the upper pulpy tissues of the under leaf, while the lower epidermis was seldom or little eaten and served as the floor of their feeding grounds. The rejected portion of the leaf was at this time of a thin papery nature, light brown or reddish-brown in color, showing plainly the network of little veinlets, and is characteristic of the work of the insects at this stage. The caterpillars are social insects, feeding

[1] Letter of Aug. 18, 1909.

together on a single leaf, and as one leaf is consumed a fresh one is involved in the web, to be destroyed in like manner. By these operations there was soon formed a nest which, on being dissected, was found to be composed of the remnants of several leaves tightly woven together by silken threads. Interspersed in the cluster were the caterpillars themselves together with their molted skins and excremental particles. The nests were subsequently abandoned and the caterpillars marched "en masse" to higher leaf clusters or to the top of a terminal shoot, spinning webs as they advanced. As they approached maturity during the latter part of June the caterpillars were more active and ravenous. Whole leaf clusters were covered with webs and then completely devoured with the exception of the midribs, larger veins and stems. The injuries to the seedlings varied somewhat in extent but colonies of caterpillars from one dozen to two dozen in number usually completely defoliated a plant, while in the axils of the shoots and stretching from the tips of each shoot to the central stalks of the seedlings were the tenuous webs of the insects. Plates XLV and XLVI. The tents were at first whitish and compact, but on exposure to the weather and from stains due to moisture acting on the excrement and fragments of leaves they became discolored and ragged. On pupating, towards the latter part of June, the caterpillars spun their cocoons in the webbing in the tops of the seedlings; and in this operation, as in feeding, the social instinct was strongly manifested. As if by a given signal the larger number of them ceased feeding and, abandoning the foliage and taking positions in the web that were parallel to and apparently of equal distance from their neighbors, they spun their cocoons side by side, forming a cluster as illustrated in Plate XLI.

BREEDING RECORDS.

Some caterpillars of *padellus* were observed feeding on cherry seedlings on June 23, 1909, and judging from their sizes and markings, all of them were at this time apparently mature. On June 28 some of the larvæ commenced to pupate, and on July 9 the first moths made their appearance. At this latter date a few caterpillars had not yet spun up. The moths lived in the breeding cages through July and one specimen survived until August 18.

In 1910 mature caterpillars of *malinellus* were found on apple seedlings on June 21. Five days later they commenced to spin cocoons and nearly all of them were in the pupal state by the first week in July. A few moths appeared July 6 but the adults were out in their largest numbers about July 14. Although the majority of them had transformed a few larvæ were still unchanged at this latter date. Egg deposition was first observed on July 18, when practically all of the moths had emerged. One moth lived until August 10.

In 1911 some caterpillars continued to feed on apple leaves until June 30. Pupation commenced June 26 and continued until July 6. Adults first appeared on July 10, and some continued to emerge until July 17. One moth lived until August 15.

During 1912 a colony of caterpillars, apparently in the second larval instar, was collected on June 12 and these on June 24 were in the fourth instar. On July 1 the caterpillars began to pupate and the last cocoon was spun July 17. Moths made their appearance on July 10 and some continued to emerge until July 15. One moth which was confined in a breeding cage lived until August 17.

FUTURE IMPORTANCE OF THE INSECTS.

The occurrence of the Yponomeuta caterpillars in New York during recent years raises the question as to the rôle these insects are destined to play as fruit pests in the United States. This cannot be answered satisfactorily as so little data is available upon the actual behavior of these lepidopterons in this country. Our knowledge regarding them in New York is limited solely to a small territory about nursery plantings in certain nursery centers, and if they exist in other states they have apparently not attracted attention. With the ability of these insects to survive the conditions incidental to the importation of nursery stock from abroad and to escape the ordinary nursery inspection, the wonder is that they have not before this succeeded in establishing themselves along the avenues of trade in America. For it is to be noted that in New York a close supervision over shipments and plantings of imported nursery stock has only been maintained since 1909 and the condition of foreign purchases with respect to the ermine moths and other dangerous species as a result of more rigid inspection is well known. If earlier importations were as commonly infested with these pests as they have been during the past four years it would seem not improbable that somewhere these moths have made their escape from nurseries to adjoining plantings where perhaps they have secured a foothold. In states where there has been no such inspection the danger that such has taken place is obviously much greater.

Since the discovery of the ermine moths in this State the Division of Nursery Inspection has taken special precautions with imported stock and whenever infested plants have been detected they have been destroyed. In addition the surroundings of nurseries have also been inspected and there has so far been no evidence that these lepidopterons have gained a footing in New York. Nevertheless pests of foreign origin have entailed such great losses upon our farmers that it would be unwise for the nursery-inspection service in all of the states not to recognize the danger threatened by these moths and seek by precautionary and other measures to prevent them from becoming permanently established in this country.

A NATIVE SPECIES OF ERMINE MOTH.

There is one native species of the genus Yponomeuta which is *multipunctellus* Clem. Dyar records the Atlantic states as its range of distribution; and according to Chambers it is very common in Kentucky, while Gaumer has obtained specimens in Kansas. The caterpillar feeds on the leaves of *Evonymus atropurpureus* Jacq. and spins its webs over the plant as is characteristic of the insects of this genus. This species differs from European forms by the larger number of black dots on the front wings and the marked difference in the hind wings of the sexes. All the wings of the male are white while the female has the anterior wings white and the posterior wings dark gray.

NATURAL ENEMIES.

The ermine moths have a large number of natural enemies, the most important of which belong to the orders Hymenoptera and Diptera. Ratzeburg [1] has enumerated over thirty hymenopterous species which are said to attack these insects. In southern Russia, according to Mokshetsky [2] twelve species of hymenopterons and three species of dipterons prey upon *malinellus* and during some seasons they exert a marked regulatory and repressive action upon the multiplication of this pest. A common and most efficient enemy of both *padellus* and *malinellus* is the remarkable chalcid, *Encyrtus* (*Ageniaspis*) *fuscicollis* Dalm., which presents the exceptional phenomenon of polyembryony [3] and possesses immense reproductive powers.

Among collections of Yponomeuta moths received from Europe there were included a number of unnamed parasites which, through the courtesy of Dr. L. O. Howard have been identified [4] as follows: *Herpestomus* n. sp., *Angitia* sp. and *Tetrastichus* sp. from *malinellus* from France; *Discochæta evonymellæ* Ratz. from *padellus* from France; *Cnemedon vitripennis* Meigen from *padellus* from Holland; and from *malinellus* from Japan, *Herpestomus* n. sp. which according to Kuwana is the only parasite which attacks this lepidopteron in this country.

In spite of the large number of Yponomeuta caterpillars which have been found in New York, it is worthy of record that we have not reared any of the well known parasites which abound in the normal range of distribution of these pests. The failure of the more common and efficient species to accompany the ermine moths

[1] Die Ichneumon. d Forstins. Bd. 3, p. 259.

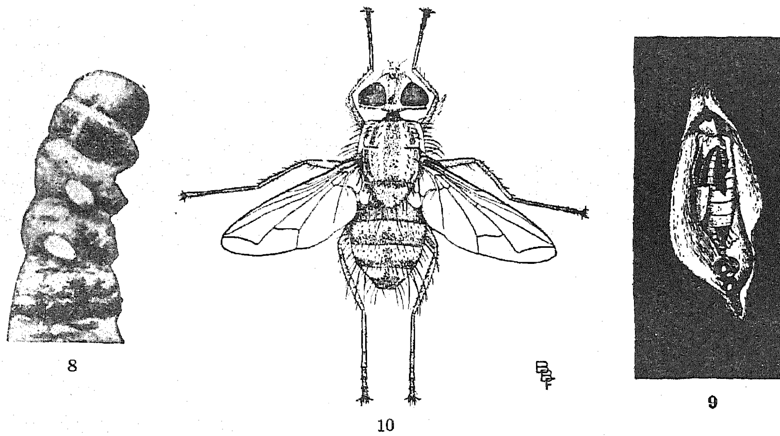
[2] The Apple Moth, 1907.

[3] Marchal, Paul. Recherches sur la Biologie et le Developpement des Hyménoptères Parasites — La Polyembryonie Spécifique ou Germinogonie, *Arch. Zool. Exp.*, 4, 2:257-335, 1904.

[4] Identifications of Hymenoptera by Mr. J. C. Crawford, and of Diptera by Mr. J. R. Malloch.

is a striking illustration of how foreign insects upon their introduction into the United States may find their struggle for existence a comparatively easy one, and by virtue of the balance in their favor become a serious item for economic consideration.

From *padellus* taken from cherry seedlings in New York we have bred a few specimens of *Mesochorus* sp., while the most common parasite of both *padellus* and *malinellus* was the tachinid, *Exorista arvicola* Meig. Some colonies had as many as 25 per ct. of the caterpillars carrying from one to three eggs of this fly, which were in the constrictions principally of the head and thoracic segments. The eggs are of a cream color and measure about .52 mm. long,



AN ERMINE MOTH PARASITE, *Exorista arvicola* MEIGEN.
8, Eggs on *malinellus* caterpillar; 9, puparium in *malinellus* pupa; 10, adult.
(All figures enlarged, last greatly)

.33 mm. wide and .19 mm. high. They are oval in shape, one end being broader than the other and are convex on the upper side. The surface is smooth and is covered with a delicate tracing of raised lines which give the appearance of a network of cells, pentagonal or hexagonal in outline. In hatching, a crack forms around the base about the wider end and extends upwards around the sides to about the middle. The portion above the crack raises up like a lid. The eggs of *arvicola* were first observed on mature caterpillars on June 25, 1912, which began to pupate on July 2. Moths from nonparasitized caterpillars commenced to emerge on July 10, while the tachinids appeared from July 10 to July 12.

A capsid,[1] *Atractotomus mali* Meig., is listed as an enemy of the ermine moths, and starlings [2] are said to feed upon the caterpillars.

[1] Pommerol, *Rev. sc. Bourbonn.* 14:18-23, 1901.
[2] Theobald, 2nd Rept. p. 35, 1904.

METHODS OF CONTROL.

The present situation regarding the ermine moths suggests the great importance of a careful inspection of nurseries, especially of the plantings of foreign-grown seedlings. Owing to the inconspicuousness of the egg masses, due to their small size and their color, which resembles that of the bark, very few of them are likely to be detected at the customary examination at the time of spring deliveries when the stock is being unpacked and sorted. The most effective work can be done during June, when the inspector should look for plants which show the webs or tents of the insect. Plates XLIV and XLV. All infested plants should be uprooted and destroyed. Experience has demonstrated very clearly the importance of more than one examination, and if two are made one inspection should be planned for the latter part of June when the work of the insects will be more conspicuous because the caterpillars are then full grown and will have spun their larger webs. If the work is delayed beyond this time there is danger that the insects may have pupated and transformed to moths. As insects may have escaped from previous infestations, premises adjoining nurseries should be similarly examined.

The caterpillars are quite susceptible to arsenical poisons and should it ever become necessary to combat them in plantings of older trees little or no modification will probably be required in existing spraying practices for orchards.

ACKNOWLEDGMENTS.

For literature and specimens of insects we are indebted to Prof. George H. Carpenter, Dublin, Ireland; Prof. R. Stewart Mac Dougall, Edinburgh, Scotland; M. J. de Joannis and Dr. Paul Marchal, Paris, France; Dr. L. Reh, Hamburg, Germany; Mr. Sigismond Mokshetsky, Crimea, Russia; Prof. W. M. Schöyen, Christiania, Norway; Prof. Sven Lampa, Stockholm, Sweden; Prof. J. Ritzema Bos, Wageningen, Holland, and Dr. S. I. Kuwana, Tokio, Japan.

Prof. C. H. Fernald allowed the use of his library and the card catalogue of entomological literature at the Massachusetts Agricultural College, for which courtesies we are under great obligations. Prof. J. H. Comstock kindly permitted the use of the library of the Department of Entomology of Cornell University for reference purposes. For the compilation of the bibliographies, aside from references to economic literature, we are largely indebted to Mr. H. E. Hodgkiss of this department. The translation of Mokshetsky's treatise was the work of the late Dr. Francis P. Nash of Hobart College. His interest in our study and his disinterested labor amid the exacting duties of his own specialty calls for our gratitude and appreciation of his scholarly attainments.

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[1] Titles marked by asterisk (*) have not been verified.

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REPORT

OF THE

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TABLE OF CONTENTS.

REPORT OF THE DEPARTMENT OF HORTICULTURE.

INFLUENCE OF CROSSING IN INCREASING THE YIELD OF THE TOMATO.*

RICHARD WELLINGTON.

SUMMARY.

The infusion of new blood obtained by crossing somewhat closely related varieties has been found, in many plants, to increase the vigor and yield of fruits to a very marked degree. Among the common commercial crops, corn, bean and tomato have been proven experimentally to be greatly benefited by such crossing.

The increase in vigor and size produced by crossing is undoubtedly due either to the heterozygous condition, which stimulates the growth of either the size or the number of cells; or to a combination of two or more size-increasing characters, such as thick internodes and long internodes, which dominate over characters of decreasing dimensions.

All the experiments on tomato crosses conducted at this Station during the years 1907-1910 have given consistent gains in favor of the yield of the F_1 (the first filial) generation; and the F_2 (second) and F_3 (third) generations have fallen off in yield in direct ratio to the decrease in the number of heterozygous plants. When a homozygous condition for all the plants in a strain has been obtained, the average yield of the plants should remain constant from year to year, varying only with the external factors,—food, moisture, and temperature. Thus, if the F_3 plants, which were used for the production of the F_4 generation grown in the summer 1910 were mostly homozygous, the non-drop in yield can be understood.

The results obtained in these experiments warrant the production of F_1 generation tomato seed not only by the grower but by all seedsmen who wish to furnish the best grade of seed to their buyers. The production of such seed requires time and care, and consequently, it must be sold at higher prices.

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* A reprint of Bulletin No. 346, March, 1912; for "Popular Edition," see p. 823.

Recommendations are given for making tomato crosses and also precautions that are essential for the maintenance and the obtainment of desirable characters. In conclusion, a few suggestions are given as to what commercial varieties may be improved by crossing.

INTRODUCTION.

That increase of vigor and of size is obtained by crossing plants and animals not too closely related is a well established principle in the biological world. The individuals crossed may be of the same variety or different varieties, and of the same or closely related species; but the relationship must not be so distant as to induce sterility and weakness. This principle is so well established that many animal breeders consider the infusion of new blood as a necessity for the preservation of highly prized qualities. Theoretically, if all the characters possessed by a variety or other group of individuals were in a homozygous or pure condition, no inferior individuals would be produced either from the self-fertilized individuals or from the matings of perfect brothers and sisters; but unfortunately, this high standard is rarely or never obtained, for all highly organized individuals are made up of many characters, and a combination of only perfect characters in an individual is practically impossible.

The principle that the offspring of crossed plants are usually more vigorous than their parents was first made prominent by Knight, but the experimental proof of the principle was left to Darwin (10)* who, in his work "Cross and Self Fertilization in the Vegetable Kingdom," built a foundation that still remains unshaken. Darwin found exceptions to the general law that plants crossed with fresh stock produce offspring of greater height and of greater weight than the self-fertilized plants, a notable example being *Eschscholtzia californica,* its self-fertilized plants surpassing the cross-fertilized plants in height in three out of four cases, regardless of the fact that the crosses yielded far more seed than the self-fertilized plants. Perhaps Darwin made this cross be-

* See Bibliography for reference numbers enclosed in parenthesis.

tween genotypes inferior to the average plants, and consequently the offspring were inferior to the average. In the case where the cross surpassed the average plants, genotypes superior to the average may have been used. The transmissive power of individuals can be determined only by the study of the progenitors and the offspring, not by an inspection of the individuals.

In 1876, Dr. W. J. Beal (1), then of the Michigan Agricultural College, arrived at the conclusion that a mixture of varieties was desirable, and in his discussion on changing seeds, he said: "To improve or infuse new vigor into varieties (or races I should more properly call them) I propose in case of corn and some other seeds to get seeds from remote parts where it has been grown for some years, and plant near each other and mix them. Since making the above notes (the idea was originated with myself) I have been delighted in reading Darwin's new work on 'Fertilization of Plants'". After two years of experimenting, Beal (2) made the following statement: "Mr. Darwin had not tested the crossing of flowers by foreign stock in cases of our fruits, nor had he tried the same on but few of our vegetables. He had not tried it on any of the cereals except on Indian corn, and on this imperfectly, because corn will not ripen in the open air in England. It seemed to me the greatest chance ever offered to make some experiments in this country for the benefit of our farmers." In a cross between two strains of yellow dent corn grown by Mr. Wolton and Mr. Hathaway, an increase in the yield was obtained which exceeded the yield of the uncrossed dents in the proportion of 153 to 100. In the bean crosses, the crossing being left to the insects, Beal secured remarkable results — the crosses giving 1,859 pods to 992 pods of the uncrossed or pure variety. The bean seed of the crossed stock weighed 70.33 ounces, the seed of the uncrossed stock 29.77 ounces; or in other words, an increase in weight of 236 to 100 was found in favor of the crossed bean.

In 1879, at a Connecticut farmer's convention, Prof. W. H. Brewer (6), of Yale College, stated that a Mr. Hinman had found a mixture of five varieties of corn — even though poor and good

races were represented — better in yield of good corn than the average crop. The increase was thought to be maintained the second and third years, but after the second year, the relative proportion of the poor corn increased. In 1889, Denton (12) made the following statement in his article on sorghum hybridization: "In regard to the effect of crossing varieties, it can be said that it seems to increase the vigor of the plants sometimes in a wonderful degree. The crossed canes are often much larger and taller and often have much heavier seed-heads than either parent form."

Many conclusive statements have been published on the beneficial effects secured in first-generation crosses of corn; but since these works are so well reviewed by G. N. Collins (8) it is only necessary to call attention to his article. Among the papers noticed those of C. L. Ingersoll (19), J. W. Sanborn (26), G. W. McCluer (21), G. E. Morrow and F. D. Gardner (22, 23), C. P. Hartley (16), G. H. Shull (29, 30, 31) and E. M. East (13, 14) are well worthy of study.

In addition to these positive proofs in regard to the increase of vigor and yield, we find other statements in recent articles on breeding which confirm the belief that the principle is not restricted to a few genera and species. Dr. H. J. Webber (32), in a paper on cotton breeding published by the American Breeders' Association, writes: "The hybrids of the first generation where a fuzzy-seeded type of upland was used have almost uniformly the following characters: They are taller, larger, and more vigorous than either parent, and have leaves in general intermediate in shape."

A. D. Shamel (28) in the same publication, but one year later, makes the statement: "Self-fertilized tobacco seed, the result of the closest possible degree of inbreeding, has been conclusively demonstrated by four seasons' experience and experiments in extensive fields of different varieties of tobacco to produce more vigorous plants than seed cross-fertilized within the variety. Crosses of different strains of tobacco, however, give increased vigor of growth, leaf and seed production."

Keeble and Pellew (20) in their study of the mode of inheritance of stature in peas found that the first generation crosses between the half-dwarf varieties Autocrat and Bountiful greatly surpassed either parent in height. Since one variety possessed a thick stem and the other long internodes, the authors came to the conclusion that both of these factors were requisite for the production of maximum growth in the pea. The explanation is best given in their own words: "The suggestion may be hazarded that the greater height and vigor which the first generation of hybrids commonly exhibit may be due to the meeting in the zygote of dominant growth-factors of more than one allelomorphic pair, one (or more) provided by the gametes of one parent, the other (or others) by the gametes of the other parents." This hypothesis was supported by a close approximation to the 9:3:3:1 ratio which signifies the presence of two allelomorphic pairs.

An older hypothesis to explain the increase in vigor, which does not essentially disagree with that of Keeble and Pellew, is one postulated by G. H. Shull (31). He writes: "In 1908, I suggested a hypothesis to explain the apparent deterioration attendant upon self-fertilization by pointing out that in plants, such as maize, which show superiority as a result of cross-fertilization, this superiority is of the same nature as that so generally met with in F_1 hybrids. I assumed that the vigor in such cases is due to the presence of heterozygous elements in the hybrids, and that the degree of vigor is correlated with the number of characters in respect to which the hybrids are heterozygous. I do not believe that this correlation is perfect, of course, but approximate, as it is readily conceivable that even though the general principle should be correct, heterozygosis in some elements may be without effect upon vigor, or even depressing. The presence of unpaired genes, or the presence of unlike or unequal paired genes, was assumed to produce the greater functional activity upon which larger size and greater efficiency depend. This idea has been elaborated by Dr. E. M. East and shown to agree with his own extensive experiments in self-fertilizing and crossing maize. He suggested that

this stimulation due to hybridity may be analogous to that of ionization."

Shull further states: "A. B. Bruce proposes a slightly different hypothesis in which the degree of vigor is assumed to depend upon the number of dominant elements present rather than the number of *heterozygous* elements." Bruce's view harmonizes with the one given by Keeble and Pellew.

In addition to the benefit already noted as obtained from crossing, there are obtained others of lesser importance but probably correlated with the increased vigor, as, for example, early flowering, early maturity, hardiness and lessened liability to premature death. Darwin (10) cites many instances in which the crosses have flowered earlier than plants from self-fertilized seed — and a few where the reverse order has taken place. *Cyclamen persicum* is a marked case of premature flowering, for during two successive seasons a crossed plant flowered some weeks before any of those from self-fertilized seed in all four pots.

The early maturity of fruit borne by crossed tomato plants is discussed in the text of this bulletin.

The increase of hardiness of crossed plants was found by Darwin to be very marked in Nicotiana and Ipomea, both of which resisted the cold and inclement weather much better than the self-fertilized plants. "The offspring of plants of the eighth self-fertilized generation of Mimulus crossed by a fresh stock, survived a frost which killed every single self-fertilized and inter-crossed plant of the same old stock." *Eschscholtzia,* already noted as an exception, was hardier when not cross-fertilized. Self-fertilized seedlings of *Beta vulgaris* were found to perish beneath the ground in large numbers, when the crossed seeds sown at the same time did not suffer. These observations of Darwin, in addition to others on the behavior of self-fertilized seeds of the petunia give ample proof that hardiness is affected by crossing.

Since cross-fertilized plants have a greater resistance to extremes in climatic conditions, and as they are generally more vigorous than their self-fertilized brethren, it is not unreasonable

that crossed plants are less susceptible to the attack of diseases and physiological troubles. Varieties of wax beans are known to resist the anthracnose disease for a few years, and then succumb to its attack. Is this increasing damage by the disease due to a decrease in vigor, brought on by the methods of seed propagation, or have more virulent forms of the disease arisen which are capable of overpowering formerly resistant plants? This subject is beyond the theme of the author; nevertheless, this phase of the influence of crossing is too important to be overlooked.

TOMATO EXPERIMENTS.

From previous work in crossing tomatoes, Hedrick, of this Station, was of the opinion that hybrid plants produced a greater quantity of fruit than the varieties used as parents. With this suggestion as a basis for work, the author in 1907 commenced an experiment in order to determine whether crossing increased the yield of tomatoes, and if so, how much?

Methods of procedure.— For the insurance of a cross which was wide enough to give appreciable results and at the same time was not too wide, the Livingston Stone and the Dwarf Aristocrat varieties were selected. The fruit of these varieties is identical in color and so similar in shape that one can not separate them by inspection, and the shape and the size of the leaves are as similar as the fruits. The vines, however, are very distinct in stature, one being a standard and the other a dwarf. If the Livingston Stone is one of the parents of the Dwarf Aristocrat, as has been suggested by E. C. Green, an Ohio tomato breeder, the similarity of certain characters would be expected. A third variety, Hedrick, a strain of the Livingston Stone, which originated at the Michigan Agricultural College, was also used in the experiment. From previous tests and in its behavior in the following crosses, no great difference was found in the yields of this variety and its progenitor; in fact, they are so near alike that a good systematist could not separate them.

In making the first crosses for this experiment, it was the intention of the writer to make reciprocal crosses, but the plan was

frustrated on the start, as the Dwarf Aristocrat was planted too late to be used for the fertilization of the Livingston Stone and the Hedrick blossoms. Pollen of the standards, however, was secured for the fertilization of the Dwarf Aristocrat blossoms. This one-sided cross was probably just as satisfactory as if reciprocal crosses had been made; for, first, the chances are that no differences in the reciprocal crosses would have been found; and, second, the use of the dwarfs as female parents gave a check on the crossing. Since the standard condition is always dominant to the dwarf condition, the occurrence of a dwarf in the F_1 generation, under these circumstances, would indicate that the cross had not been made. No similar test could have been applied to the reciprocal cross, since standard condition might in this case have arisen either from continuance of the pure standard line or from dominance of the standard condition in the cross.

The self-fertilizing of varieties in the experiment was performed by covering the flower clusters with paper bags while the blossoms were in the bud stage, and later, when the pollen was ready for shedding, jarring every other day until the blooming was completed.

The crossing of the varieties was more difficult than the self-fertilizing and required more care. For the prevention of accidental crossing, the flower clusters were covered while in bud. One or two days before the pollen had matured, the stamens were removed with the aid of a pair of forceps or some other instrument; and two or three days later or whenever the pistils were receptive, the stigmas were covered with the pollen of the desired parent. Premature pollination always gave a very poor setting of fruit.* As the blossoms in clusters mature at different times, it was necessary to perform the emasculating and pollinating every two or three days until the work was completed. In crossing it should be remembered that the length of time for blossoms to mature depends upon the temperature and that better results are obtained when the pollen sheds freely, that is, on the bright, warm, sunny days.

* This fact is substantiated by Hartley. (See Bibliography 15.)

SUMMER EXPERIMENT OF 1908.

Seeds for the 1908 summer experiment were obtained during the winter 1907–1908 from self-fertilized plants of the Livingston Stone and Dwarf Aristocrat and from cross-fertilized plants, namely, Dwarf Aristocrat x Livingston Stone and Dwarf Aristocrat x Hedrick — the first parent in all the crosses mentioned being the maternal parent. Seeds were sown April 30, 1908, the plants pricked out on May 15, and on June 2 one hundred plants of each lot were set out in the garden. The plants were arranged so that the conditions for each plant were as nearly alike as field conditions will permit. All the plants matured except one Dwarf Aristocrat x Livingston Stone, which was accidentally destroyed. The following table gives the pounds of fruit

Table I.— Yield of Tomatoes from Parent Varieties and from F_1 Seedlings.

(Summer Experiment, 1908.)

	Dwarf Aristocrat × Livingston Stone. 1st generation (99 plants).	Dwarf Aristocrat × Hedrick. 1st generation (100 plants).	Livingston Stone. Standard parent (100 plants).	Dwarf Aristocrat. Dwarf parent (100 plants).
Time of Picking:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Aug. 18–28	197	194½	123½	83½
Aug. 29–Sept. 4	100	91	56	50½
Sept. 5–15	608	560	424½	337
Sept. 16–29	476	375	627½	375½
Total ripe fruit	1,381	1,220½	1,231½	846½
Total green fruit	1,125	1,276	856	629
Total yield	2,506	2,496½	2,087½	1,475½
Ripe fruit per plant	13.949	12.205	12.315	8.465
Green fruit per plant	11.364	12.76	8.56	6.29
Total fruit per plant	25.313	24.965	20.875	14.755
Yield per acre (2,722 plants)	68,898	67,955	56,822	40,163

produced by each lot and the periods of picking are divided into intervals of about ten days. The total yield of ripe and green fruit is given for each lot, the average amount of ripe and green fruit produced per plant, and finally the total yield of 2,722 plants — one acre with plants set 4′ x 4′ each way — based on the average yield of one plant. The results are discussed later in the bulletin.

WINTER EXPERIMENT, 1908–1909.

The seed used for the winter crop was obtained during the summer of 1908 by self-fertilizing clusters of blossoms on four or more vines of each lot, namely, the Dwarf Aristocrat, Livingston Stone, and the crosses, Dwarf Aristocrat x Livingston Stone, and Dwarf Aristocrat x Hedrick. It will be noted that two crops of tomatoes are grown in one year — the winter crop in a forcing house. This experiment differed from the preceding one in that the crosses belonged to the F_2 generation, and, therefore, a direct comparison of the results is impossible. All the dwarf plants that appeared in this second generation were discarded. According to the Mendelian law of segregation, one-third of the standards appearing in an F_2 generation are in a homozygous condition, and two-thirds, or the remainder, of the standards are in a heterozygous condition. The homozygous standard plants will always breed true to the standard type, while the heterozygous standard plants will split into one-fourth dwarf plants and three-fourths standards. It is thus very evident that we are dealing with a smaller proportion of heterozygous individuals in the F_2 generations than in the F_1 generation. The heterozygous and the homozygous plants were so similar in appearance that no separation could be made by inspection, and, therefore, both kinds were planted indiscriminately. Owing to the smaller number of heterozygous plants in these crosses, one would expect less difference in yield between the standard parent and the crosses. The results of this crop agreed with this expectation, except that the differences in the yields of the crosses and the parents were less marked than expected. Early maturity favored the crosses. The yield of this

indoor crop is so inferior to the outdoor crop that it is very evident that the strength of none of the plants was taxed. Under such conditions all the standard plants could be expected to do equally well.

TABLE II.— YIELD OF TOMATOES FROM PARENT VARIETIES AND FROM F_2 SEEDLINGS.

(Winter Experiment, 1908–9.)

	Dwarf Aristocrat × Livingston Stone. 2nd generation (30 plants).		Dwarf Aristocrat × Hedrick. 2nd generation (31 plants).		Livingston Stone. Standard parent (36 plants).		Dwarf Aristocrat. Dwarf parent (42 plants).	
TIME OF PICKING:	*Lbs.*	*ozs.*	*Lbs.*	*ozs.*	*Lbs.*	*ozs.*	*Lbs.*	*ozs.*
Jan. 19–30	9	14½	10	3½	9	15	10	9½
Feb. 1–15	20	10	19	4	19	0	19	4
Feb. 16–28	19	5	23	9	23	8	14	10
March 1–16	23	7	26	6	33	6	24	14
March 17–April 3	27	4	19	9	24	13	16	10
Total ripe fruit	100	8½	98	15½	110	10	85	15½
Total green fruit	30	...	32	...	45	...	24	...
Total yield	130	8½	130	15½	155	10	109	15½
Ripe fruit per plant	3.35		3.192		3.073		2.047	
Green fruit per plant	1.00		1.032		1.25		0.571	
Total fruit per plant	4.35		4.224		4.323		2.618	
Yield per acre (2,722 plants)	11,840		11,498		11,767		7,132	

SUMMER EXPERIMENT, 1909.

The Dwarf Aristocrat, the Livingston Stone, and three filial generations of the cross Dwarf Aristocrat x Livingston Stone were used in this summer's experiment. The dwarf plants in the second and third generations were discarded, and, therefore, only the standards were planted. The second generation standards, as has been noted, should contain about two heterozygous to one homozygous plants, but the proportion of the two classes in

the third generation is not known, since no records of the mother plants were kept. If dwarf plants had not appeared in the third generation, one could have rightly assumed that its parents had been all homozygous standards, but as dwarfs did appear, one or more of the mothers must have been heterozygous. The law of probability favors more than one heterozygous mother, for the second generation from which the third generation was obtained should have had two heterozygous plants to every one of its homozygous plants, and, as already stated, at least four mothers were used. Unfortunately, the exact number of dwarfs was not recorded, for then one could make a rough estimation on the number of heterozygous individuals. However, if the amount of

TABLE III.—YIELD OF TOMATOES FROM PARENT VARIETIES AND FROM F_1, F_2 AND F_3 SEEDLINGS.

(Summer Experiment, 1909.)

	DWARF ARISTOCRAT × LIVINGSTON STONE			Hedrick Strain. Standard parent (54 plants).	Livingston Stone. Standard parent (45 plants).	Dwarf Aristocrat. Dwarf parent (70 plants).
	1st generation (96 plants).	2nd generation (85 plants).	3rd generation *(28 plants).			
TIME OF PICKING:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Aug. 12–20	$172\frac{5}{8}$	$132\frac{1}{2}$	$46\frac{5}{8}$	$99\frac{5}{8}$	65 11/16	$85\frac{7}{8}$
Aug. 21–Sept. 2	$130\frac{1}{2}$	68	$33\frac{1}{2}$	$40\frac{1}{2}$	$31\frac{1}{2}$	$41\frac{1}{2}$
Sept. 3–15	529	$480\frac{1}{2}$	$184\frac{1}{2}$	323	176	217
Sept. 16–28	402	342	99	151	183	$80\frac{1}{2}$
Total ripe fruit	$1,234\frac{1}{8}$	1,023	$363\frac{5}{8}$	$614\frac{1}{8}$	456 3/16	$424\frac{7}{8}$
Total green fruit	688	681	140	370	340	253
Total yield	$1,922\frac{1}{8}$	1,704	$503\frac{5}{8}$	$984\frac{1}{8}$	796 3/16	$677\frac{7}{8}$
Ripe fruit per plant	12.855	12.035	12.986	11.37	10.137	6.07
Green fruit per plant	7.1666	8.01	5	6.85	7.555	3.61
Total fruit per plant	20.022	20.05	17.986	18.22	17.692	9.68
Yield per acre (2,722 plants)	54,500	54,576	48,958	49,595	48,152	26,349

* The low number of plants grown in this generation is due to an accidental picking of seed fruits in the greenhouse.

fruit produced by a generation is any criterion of its genetical composition, it is safe to assume that the majority of the plants in this F_3 generation were homozygous — their yield corresponding very closely to that of the Livingston Stone. This assumption is further substantiated by the fact that this F_3 generation, and the F_4 generation, produced by self-fertilizing the F_3 generation, gave very similar results in the summer of 1910. This season's results show practically no difference in the total yield of the first and second generations. The total yield of the third generation and the Livingston Stone as noted above are nearly identical. The total ripe fruit per plant of the third generation exceeds that of the first and second generations — the first generation, however, leads at end of the second period all the crosses and varieties by over half a pound per plant. Further differences in the yields are discussed more fully later in the Bulletin.

SUMMER EXPERIMENT, 1910.

Seed for the summer crop of 1910 was obtained from plants of the crosses and of their parents grown in the greenhouse during the winter of 1909–1910. The 1910 experiment was conducted in the same manner as during the previous seasons, except one more generation was added, namely, the fourth. Results which corresponded with the previous ones were obtained, notwithstanding the fact that the plants suffered from several mishaps. On May 27th the plants, a little too spindling, were set out in the field. The following two days were cold and rainy and shortly afterwards the foliage turned yellowish and appeared unhealthy. The ground had been previously manured and plowed, so the trouble can be laid neither to the soil nor to the lack of food. Within a week of the date the plants were set in the field, cutworms had either destroyed or injured several plants. A mixture of sweetened bran and an arsenical poison distributed in spoonful quantities at the base of each plant stopped the work of the cutworm, but did not lessen the troubles. A rain following the application of the poisoned bran washed the soluble arsenic into

the soil, and within a day or two many plants showed injury, especially those which came accidentally in contact with the mixture. Several plants died from this poisoning, several recovered, and all probably received more or less injury. The plants that succumbed to the trouble were discarded from the experiment. The injured plants recovered after two or three weeks, and since the check to growth was probably equally distributed amongst all the lots, the results are comparable. This assumption is supported by weights obtained (see Table IV).

The plants set in the field numbered: Of the cross, Dwarf Aristocrat x Livingston Stone, 36 of first generation, 80 of second, 73 of third, and 65 of fourth; of Livingston Stone, 80; and of Dwarf Aristocrat, 44. The number from which data were secured is given in the following table.

TABLE IV.—YIELD OF TOMATOES FROM PARENT VARIETIES AND FROM F_1, F_2, F_3 and F_4 SEEDLINGS.
(SUMMER EXPERIMENT, 1910.)

	DWARF ARISTOCRAT × LIVINGSTON STONE				Livingston Stone. Standard parent (49 plants).	Dwarf Aristocrat. Dwarf parent (32 plants).
	1st generation (28 plants).	2nd generation (28 plants).	3rd generation (45 plants).	4th generation (36 plants).		
TIME OF PICKING:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Sept. 7–12	23½	15	30	31	26½	23
Sept. 13–28	119	54	112	125	186	58
Sept. 29–Oct. 15	226	211	297	256	375	74
Total ripe fruit	368½	280	439	412	587½	155
Total green fruit	406	424	589	445	632	248
Total yield	774½	704	1,028	857	1,210½	403
Ripe fruit per plant	13.161	10	9.7555	11.444	11.9898	7.031
Green fruit per plant	14.5	15.143	13.0888	12.361	12.7142	7.75
Total fruit per plant	27.661	25.143	22.844	23.805	24.704	14.781
Yield per acre (2,722 plants)	75,293	68,439	62,173	64,796	67,244	40,234

The influence of crossing is very apparent in this table — the F_1 generation cross surpassing both the parents and the other crosses in yield. The F_2 generation stands second in productivity and the F_3 and F_4 generations fall below the yield of the Livingston Stone. The number of heterozygous individuals in the third and fourth generations are not known, but they are probably few in number (see discussion on page 66).

DISCUSSION OF RESULTS.

It is well known that it is often unfair to draw conclusion on the yield of an acre, based on the performance of a few plants, but when the results are repeated for three consecutive seasons, under good and adverse conditions, and the gain is consistent, one may assume that the results are not a case of chance. Further the results are supported by similar performances of many other similar experiments on various genera and species (see Introduction).

The summer experiment of 1908 gave gains which favored the crosses to a marked extent. The Dwarf Aristocrat x Livingston averaged 4.438 pounds more fruit per plant than the Livingston Stone and 10.558 pounds more fruit than its maternal parent, or in other words, if the plants had been set 4 feet by 4 feet, that is, 2,722 to the acre, we would have obtained about six tons more fruit from this cross than from the Livingston Stone and over fourteen tons more fruit than from Dwarf Aristocrat. If the cross had been made between two standards, instead of a dwarf and a standard, the yield might have been greater, but perhaps not, as the vines of the first generation are standard in size.

The winter experiment of 1908–1909 is not comparable with the summer experiment, as the conditions are very different, and in addition, the same generations were not grown.

The summer experiment of 1909 gave lower yields for all the lots than the previous season, and this fact may be partially explained by the unusual drought which prevented the maximum

development of plants and fruits. However, as the drop in yield occurred in all the crosses and varieties in about the same proportion, the results remain comparable. The maximum yield per plant of the F_1 generation was over five pounds less than the summer of 1908, and the maximum yield per plant of the Livingston Stone, a little over three pounds less; consequently, the difference in yield of these two lots in the summer of 1909 was only 2.328 pounds, while in the summer of 1908 it amounted to 4.438 pounds. The difference, however, in yield of the Dwarf Aristocrat and the first generation obtained in 1908 is practically identical with the difference obtained in 1909, the former being 10.558 pounds and the later 10.34 pounds. Even with a small difference between the standard plants, of 2.328 pounds per plant, one would obtain an increase of over three tons per acre, that is, if the same increase held for 2,722 plants. These differences apply only to the total yield of the plants. The difference in yield of only ripe fruits is less marked, but nevertheless, worthy of consideration. In 1908 the ripe fruit per plant of the F_1 generation exceeded the Livingston Stone by over 1.6 pounds, and in 1909 the difference was over 2.7 pounds — a gain of over one pound in favor of the later year, and in 1910 there was a gain of 1.17 pounds.

The F_1 generation cross in 1910 yielded nearly three pounds more per plant than the Livingston Stone and nearly thirteen more pounds per plant than the Dwarf Aristocrat. The ripe fruit of the F_1 generation, as already noted, exceeded that of the Livingston Stone and this difference would have increased materially if the season had been longer, for the experiment closed with more green fruit on the vines of the former than on those of the latter.

In consideration of the increased yield of the hybrid or crossed tomato plants, particularly those of the F_1 generation, and since the ripening season was materially advanced, there is little question but that the crossing of tomato varieties is a sound commercial proposition.

SUGGESTIONS FOR GROWING HYBRID SEED.

1. Desirable results have been obtained by selecting plants indiscriminately, but better results would undoubtedly have been obtained if high-yielding mothers had been selected for one or more generations previous to the first crossing. This selection can be easily accomplished, as tomatoes are readily self-fertilized. The high yielding strains or pure lines having been isolated, they should be preserved for future crossing, and then the crosses can be duplicated at any future date. This is a very important consideration for the grower who is desirous of putting the same grade of product on the market from year to year. As tomato seed remains fertile three to seven years, a grower does not need to make his crosses oftener than once in three years. The seedsman, as well as the farmer, can profitably raise F_1 generation seed, provided a guarantee is not given for more than one generation, for the buyer, to maintain his quality of product, will have to purchase seed every year.

2. Too violent crosses should be avoided, as they are conducive to weakness and sterility. In a cross between Jerusalem cherry (*Solanum pseudo-capsicum* Linn.) and the common tomato (*Lycopersicum esculentum* Mill.) no seed was produced, and yet the application of pollen grains of the former caused the development of small tomato fruits — the reciprocal pollination had no such stimulating action, as the Jerusalem cherry blossoms dropped without any noticeable swelling of the ovarian tissue. This example is of course an extreme case, but it is only one of several in which sterility is known to take place — the mule being a classical case in the animal kingdom.

3. The best results of crossing can probably be obtained by keeping within a species and crossing the distinct varieties and the distinct strains. For the insurance of securing a desirable commercial tomato, one must keep in mind the inheritance of such qualities as smoothness, color, size, shape and earliness. To obtain smooth fruits, one should cross only varieties with smooth and even surfaces, as roughness will appear in the first genera-

tion. From observation of the writer, the irregularity of the surface of the tomato is thought to be correlated with the non-development of ovules. This postulation is not improbable, as Ewert has found irregularity of certain fruits, as the apple, to be due to the lack of development of seeds in one or more carpels, and many others have noted the correlation of the development of seed and its surrounding tissues — thus, a study of smoothness in some cases may mean a study of sterility.

The inheritance of color in tomatoes has been carefully studied and so it is now known that the dark red is dominant to the pink and the yellow, and that the pink is dominant to the yellow color — the submerged color in every case being the recessive.

Thus, to obtain a red fruit, it is necessary to make sure that one parent is red — the other may be red, pink or yellow; to obtain a pink fruit, one parent must be pink and the other parent either pink or yellow; and to obtain a yellow, only yellow parents can be used.

Size is inherited as if it blended into an intermediate condition, and, therefore, one should cross large fruits to obtain large fruits, small fruits to obtain small fruits, and small by large fruits, or medium by medium fruits to obtain medium sized fruits. Size is probably increased to a slight extent by the heterozygous condition, but not sufficiently to be of commercial significance.

Shape, like size, is inherited more or less as an intermediate in appearance, and, therefore, varieties not too divergent from the desired type should always be selected.

Earliness is slightly increased by crossing, but for the attainment of marked differences, one would have to make crosses with early maturing varieties or strains. The inheritance of season in the F_1 generation of the tomato is not known, but from its behavior in other plants, it is probably inherited as an intermediate condition. Caution should be taken while working for earliness, that all the other characters are all right or the attempt to improve in one direction may be off-set by a deterioration in another of equal importance.

SOME PLANTS THAT ARE KNOWN TO BE, OR MAY PROVE TO BE, BENEFITED BY CROSSING.

The tomato is not the ideal plant to cross for it requires care and time to make many crosses, but its compensating factors are the large number of seeds produced by a single fruit and the increased yield of the hybrids. The cheapness of the production of tomato seed will depend upon the number of seed borne by a variety, and consequently, the nearly seedless varieties will be the more expensive to produce. Corn is without a doubt the ideal plant to cross; for the staminate and pistillate blossoms are widely separated — the former being borne by the tassels and the latter by the ears — the silks being the pistils. The crossing of maize may be accomplished by simply planting the varieties or strains in alternating rows, and as soon as the tassels appear, remove them from one variety and allow wind to perform the pollinating. It is essential that other varieties not wanted for crossing are distantly located from the breeding plat or undesirable mixtures will certainly appear.

Among the Cucurbitaceae are found monoecious plants, as squash, melon and cucumber, which are easily crossed and are prolific in seed production. If the beneficial effect of crossing holds for this family, it will certainly be a valuable addition to the list of plants known to be improved by hybridizing.

A very important field lies open to the investigators, who have the opportunity and the patience to select the best strains or pure lines from the complex composition of varieties propagated by seed, and who have the ability to recombine these strains in such a way as to obtain the highest awards given by nature.

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AN EXPERIMENT IN BREEDING APPLES.*

U. P. HEDRICK AND RICHARD WELLINGTON.

SUMMARY.

1. There have been few efforts to improve apples, nearly all varieties having come from chance seedlings. Under the knowledge and inspiration of recent discoveries in plant-breeding we ought to breed this fruit more advantageously than in the past. This bulletin is a record of an experiment in breeding apples in the light of the new knowledge.

2. Apples are improved only by the introduction of new varieties. These originate chiefly from cross-fertilized seeds. Possibly a few have arisen from self-fertilized seed and it is known that a very few sorts have come from sports or bud-mutations. It is very doubtful if apples can be improved by bud selection and the so-called "pedigreed" stock is probably worth no more than trees grown under general nursery practices.

3. The material for this experiment came from 148 crosses made in 1898 and 1899. Grafted trees of these crosses began to bear in 1904 and the seedlings came in fruiting in 1908. The crosses have been studied from both the grafts and seedlings, the orchards having had the care usually given commercial plantations.

4. The crosses which have fruited, with the number of each, are:

Ben Davis X Esopus	4
Ben Davis X Green Newtown	13
Ben Davis X Jonathan	11
Ben Davis X McIntosh	11
Ben Davis X Mother	20
Esopus X Ben Davis	29
Esopus X Jonathan	2
McIntosh X Lawver	1
Ralls X Northern Spy	9
Rome X Northern Spy	1
Sutton X Northen Spy	5

* A reprint of Bulletin No. 350, June, 1912; for "Popular Edition," see p. 840.

5. General considerations arising from the experiment are: 1. These crosses strikingly contradict the idea that seedling apples revert to the wild prototype. 2. The stimulus of hybridity is very marked in the vigor of the crosses under consideration. 3. The behavior of some of the crosses strongly suggests that apples may be prepotent in one or more of their characters.

6. The inheritance of a number of characters is discussed; namely, color of skin, color of flesh, shape, size and acidity.

7. In color of skin, the fruits in which yellow predominates over red seem from the data in hand to be in a heterozygous condition for yellow and red. The fruits in which red predominates are either homozygous or heterozygous. The pure yellows are homozygous.

8. The data are not at all conclusive as to color of flesh but suggest very strongly that Ben Davis and McIntosh, crosses of which gave the best opportunity of studying color of flesh, both carry yellow and white, the white being recessive.

9. Establishing the laws of inheritance of size and shape in apples promises to be a most difficult task, since these characters depend upon so many external as well as internal conditions. The data from these crosses favor the supposition that these characters are inherited practically as intermediates.

10. The study of the inheritance of sweetness and sourness is based wholly upon crosses of sub-acid varieties. The fact that sweet apples appear in nearly all of the crosses is significant. The crosses are so few that the exact 3:1 ratio could hardly be expected in all cases, yet the total progeny indicates strongly that crosses of these sub-acid varieties break up in the proportion of three sour apples to one sweet one.

11. The following is a summary of the inheritance of the characters discussed, in the several varieties:

Ben Davis does not carry yellow; in transmitting shape it is less prepotent than either Green Newtown or Jonathan; as a rule its crosses are intermediate in size; sweetness is carried as a recessive.

Esopus probably carries yellow skin color; shape is intermediate in its progeny; the variable size of its progeny indicates that at least one of its recent ancestors was small; sweetness is carried as a recessive.

Green Newtown possibly carries a red unit factor; the distinctive oblique shape of this variety is prepotent in crosses with Ben Davis; the progenitors of Newtown probably bore large fruits; sweetness is recessive.

Jonathan carries only red skin color; it is more prepotent than Ben Davis in the transmission of shape; sweetness is recessive.

Lawver entered into too few individuals for even rough assumptions.

McIntosh seems to carry both red and yellow skin colors; the white flesh of the McIntosh behaved as a recessive to the yellowish-white color of the Ben Davis; in shape as many progeny of Ben Davis crossed with McIntosh resembled one parent as the other and all were intermediate in size; the ratio of two sweet to nine sub-acid apples supports previous statements that sweetness is recessive.

Mother probably does not carry yellow; shape and size seem to be inherited as intermediates; sweetness is inherited in 2:3 instead of 1:3 proportions.

Northern Spy carries red and yellow skin color; shape seems to be transmitted as an intermediate; its gametes carry large and small size; this variety does not carry sweetness.

Ralls probably does not carry yellow; is more prepotent in transmitting shape-determining factors than Northern Spy in the cross with this variety; the variability in size of its crossed progeny is so great as to suggest that among its recent parents were large and small-fruited apples; it seems not to carry sweetness.

Rome entered into but one individual, hence nothing can be said as to the inheritance of its characters.

Sutton probably carries yellow; it is less prepotent as to shape than Northern Spy; its crosses did not give small fruits; it did not carry sweetness.

12. The following is the disposition of the crosses as to propagation: From the eleven Ben Davis X Jonathan crosses, one is marked for propagation, four for further testing and six for discarding. Ben Davis X Mother gave two seedlings worthy of propagation and eighteen for discarding. Ben Davis X Esopus produced four worthless seedlings but the reciprocal cross contributed two worthy of propagation, one for future testing,

twenty-six for discarding. Ben Davis X McIntosh gave two desirable varieties, three for further testing and six for discarding. Ben Davis X Green Newtown gave four desirable varieties from thirteen seedlings. Esopus X Jonathan gave one for further testing, one for discarding and McIntosh X Lawver produced one individual which is still retained for further test. The Northern Spy crosses have done well, for Sutton X Northern Spy gave two worthy of propagation, three worthy of further testing and none for discarding. Ralls X Northern Spy produced one desirable variety, one worthy of further consideration and seven undesirables; and Rome X Northern Spy gave one of no special merit.

13. Varieties named, after counties in the State, described and distributed, are: Clinton, Cortland, Herkimer, Nassau, Onondaga, Oswego, Otsego, Rensselaer, Rockland, Saratoga, Schenectady, Schoharie, Tioga and Westchester.

14. The behavior of the crosses in this experiment gives some indications of how certain characters are transmitted when found in the varieties involved and forms a basis therefore, for breeding work with these varieties, and suggests, at least, how the characters discussed will behave in other varieties that may be used in breeding.

15. The chief difficulties in the application of Mendelian principles to the breeding of apples are likely to be: 1. The determination of the factors by which the various characters are transmitted. 2. Complications arising when a character skips a generation — does not appear in the F_1 generation. 3. It is possible that some characters may be linked together in transmission and that others will repel each other. 4. The bringing together of complementary characters may result in reversions and thus produce unexpected characters. 5. The breeder will not be able to obtain new characters by working with Mendelian characters nor augment those that exist if we possibly except size and vigor. 6. It will be necessary to work with large numbers of plants — difficult with apples. 7. Disappointments will often come from the attempt to work with fluctuating variations. 8. There is likely to be much confusion between "simple Mendelian characters" and "blending characters."

INTRODUCTION.

Apples have been cultivated for many centuries, yet there seem never to have been well-ordered efforts to improve this fruit. Of the three thousand or more varieties which have been described, nearly all, as their histories show, have come from chance seedlings. When one seeks to know what the raw material of our cultivated apples was, and how it has been fashioned into its present shape, he finds little but surmises. It is true that until recently — until the onrush of discoveries made by Mendel and his followers — plant breeding was little more than dallying in the by-ways of biological science; but there seems to have been no time when even what was passing as current coin in plant-breeding was used to any considerable extent in improving the apple or, for that matter, any tree fruit. Not only has there been apathy, but error and laxity are more prominent than truth and exactness in the little work that has been done.

It is not strange that pomologists have been laggards while agriculturists, gardeners and florists have at least been working. For, as all can see, it is much more difficult to put the principles and methods of plant breeding in practice with fruits. Thus, with trees, much more time and money are required to secure results; the harvests have been and must ever be more meagre, for but comparatively few trees can be grown in breeding experiments; individuals have not taken up the work with fruits, because the pecuniary rewards have been small — in most cases nil; until recently there have been no public institutions having plant-breeding to do and these have been forced to work in the fields where the yields are most immediate; plant-breeding has been so changeable that it has been impossible to lay out a piece of work with fruits and complete the task as planned; lastly, such laws of breeding as we have had have been worked out for herbaceous plants and fruit growers have very generally believed that trees do not follow the same laws — a notion that crops out not infrequently in the scientific literature of the past.

We ought now, however, to be able to breed fruits much more advantageously than in the past. Under the ferment of Mendelian ideas a sufficient body of knowledge has been produced to

enable plant breeders to shorten and improve their methods. The old feeling of uncertainty is largely gone, the limitations of breeding are better known, and the breeder can now take aim where before he shot at random. While his tasks, in many respects, are much more difficult than those of the farmer, florist and gardener, the breeder of fruits can take cheer in the fact that almost nothing has been done in his field and that he has practically a virgin soil to till.

The discoveries of the past ten years make a foundation for fruit-breeding but not much real building can be done until we have had more experience in handling the material. With the apple, in particular, because of the time it takes to obtain results, a decade at the very least, it is important that workers give to their fellow-workmen the results of experiments as rapidly as precise and accurate information, be it ever so slight, is obtained. It is with the hope of adding a little to the small store of apple-breeding knowledge now in existence that we are reporting at this time on an experiment in crossing apples at the Geneva Station. Though the experiment has been running fourteen years, this is still but a preliminary report.

Before noting the behavior of the crosses to be discussed, it seems necessary to give brief consideration to the origin of varieties of apples.

THE ORIGIN OF VARIETIES OF APPLES.

Apples, as we shall try to show later, are improved only by the introduction of new varieties. That is, there is no evidence to lead one to suppose that varieties are ever changed for better or worse by selection or degeneration as cumulative processes. Strains, or possibly varieties, rarely arise by selecting bud-mutations but no one as yet has demonstrated that by continuous selection new characters can be developed in apples. It, therefore, becomes highly imporant that we know how varieties of apples originate. Fortunately, data are at hand upon which it seems safe to generalize. *The Apples of New York*[1] gives all that can be learned of the histories of 698 standard sorts of this fruit. How have these come into existence?

[1] Beach, S. A. *The Apples of New York.* N. Y. Agrl. Ex. Sta. 1905

Data from The Apples of New York.— No case is recorded in this work of a variety known to have come from a self-fertilized seed.

The seed parent is given for 39 varieties, probably accurate data for it would be most natural for a man growing seedling apples to keep a record of the seed parent if he knew it.

The seed and pollen parents of but one of the 698 apples under consideration are certainly known; the one is the Ontario. Parents are named for the Pewaukee and Gideon, but in each case one of the parents was guessed.

Four varieties are said to have come from sports or bud-mutations.

Sorts from seeds sown without knowledge of either parent and from natural seedlings are put down as chance seedlings; of these there are 71.

The origin of 517 of the 698 varieties is unknown. Among these "unknowns" are many of the best commercial and home apples.

A discussion of this data should give some idea of the past and the present status of apple-breeding.

Varieties from self-fertilized seed.— That none of the varieties of apples grown in America, many of which came from Europe, however, are known to have come from self-fertilized seed is a surprising fact. Either the few men who have tried to produce new varieties of apples have not "selfed" seed, or if such seeds have been produced, the resulting trees have been worthless. There are no records of attempts to obtain varieties of this fruit through self-fertilization. Though some of the chance seedlings or some of those of unknown origin may have so originated, it is not likely, for two reasons, that many have. As is well known, the apple is partially self-sterile, the blossoms of most varieties being much more receptive to pollen from other sorts than to their own. As contributory evidence to this preference for cross-pollination, it may be stated here, although the facts will be set forth more fully later in the text, that it seems almost impossible to obtain self-fertilized seed from the crossed trees of which this bulletin is a record.

A second reason for assuming that few varieties of apples come from self-fertilized seed, is that the apple, in common with many plants, loses vigor under self-fertilization and new varieties are not likely to be selected from feeble seedlings. When cross-fertilization is preferred by a plant, it may, generally speaking, be assumed that the offspring of self-fertilized seed will be wanting in vigor, size and fertility. Two experiences with inbred apples at this Station, while the number of trees involved is too small to give the experiments much weight, are suggestive as to the effects of inbreeding apples.

One of these lots of trees consists of four seedlings from Hubbardston self-pollinated, which are and always have been, with the best of care, but weaklings. None of these bore fruit until in their fourteenth season and then two of them matured one apple each. These Hubbardston seedlings are growing in the same block under the same treatment as the crosses to be discussed, which are wonderfully vigorous and productive. The weakness and sterility of the selfed seedlings are so striking that it should be counted as something more than a coincidence. The behavior of these Hubbardstons may be compared with that of the crosses in Table II, page 465. In 1907 several hundred Baldwin apple seeds taken from fruits in an orchard in which no other varieties were growing, were sown at this Station and though there was a fair germination but 27 rather weak plants survive — the others having succumbed to damping-off fungi, droughts and cold. In the many different batches of apple seedlings grown at this Station during the past six years, none have shown such lack of vigor as these selfed Baldwins.

From the fact that offspring of self-fertilized seeds have played so small a part in the origination of varieties, and because of the known consequences of close interbreeding, the use of selfed seed does not promise much in breeding apples.

Varieties from cross-fertilized seeds.—Although the data given show that but one named variety is certainly known to be the result of a cross, yet in spite of lack of exact knowledge it seems certain that nearly all varieties of apples are crosses, because, as has just been stated, apples normally prefer cross-pollination; and selfed seedlings lack vigor and would largely be weeded out

through selection. The experiment in hand has to do only with crossed apples and the behavior of these trees, since we have almost no data from the past regarding crossed apples, should be of especial interest to apple growers and breeders.

If it be true that the apple is to be chiefly improved by crossing, apple breeding becomes a comparatively simple though not necessarily an easy matter. The blossoms are readily interpollinated, the seeds grow as readily as those of vegetables or flowers, and there remains but to select the tree of promise and to propagate it. A little manual skill, knowledge of what exists and of what is wanted in varieties of apples, patience and time, with land to grow large numbers of seedlings, added to definite knowledge of the laws of plant breeding, seem to be the requisites for breeding apples by crossing.

Varieties of apples from mutations.— Four varieties in *The Apples of New York,* are said to have come from sports. These are: Olympia, Banks, Collamer and Red Russet.

The evidence regarding these varieties needs to be examined critically. Olympia was sent out as a "sport from the Baldwin," an "improved Baldwin." Four trees in a Baldwin orchard near Olympia, Washington, produced larger and better colored fruits than the neighboring plants. Cions seems to reproduce the large size and high color, and the novelty was called the Olympia. At this Station, the Olympia from cions taken from trees grown from the originals, is the Baldwin. We are led to conclude that the variation in the trees in Washington was due to some unusual environmental condition and that there is no ground for calling it a "sport," a "mutation," or a new variety.

Banks is given as a bud-mutation of Gravenstein differing from its parent in being bright red, less ribbed, more regular in shape and a little smaller. This variation appeared on a branch of a Gravenstein tree in the orchard of C. E. Banks, Berwick, Nova Scotia, and is now widely grown about the place of its origin. Gravenstein seems to be productive of red variations, Oberdieck[1], Gaucher[2] and Leroy[3] having described variations similar to Banks in Europe. More recently another one

[1] Oberdieck, Deut. Obst. Sort. 1881.
[2] Gaucher, Pom. Prak. Obst. 1894.
[3] Leroy, Dict. Pom. 1877.

has appeared in Washington quite as distinct as Banks but similar to it.[1]

Collamer is a bud-mutation from Twenty Ounce found in the orchard of J. B. Collamer, Hilton, New York, sometime previous to 1900 in which year its propagation was begun. Collamer differs from Twenty Ounce in bearing fruits more highly colored, less mottled and striped, and more regular in shape. The trees differ only in having twigs in the mutation more deeply tinged with red. Mr. Grant Hitchings of South Onondaga, New York, has another red bud-mutation from Twenty Ounce, but so far no one has grown the Collamer and Hitchings sports under conditions that would warrant making a distinction between them.

Red Russet is a well known bud-mutation of the Baldwin, having appeared on a tree at Hampton Falls, New Hampshire, about 1840. Instances are known in which both smooth and russeted Baldwins are borne on the same tree. It is an interesting fact that the Baldwin, the most largely cultivated apple on this continent and under cultivation for at least 170 years, has given but this one authentic variation and that by a bud-mutation — no permanent selections having been made from the many fluctuating variations.

The study of these 698 varieties gives no evidence of seed-mutations in apples, and it seems to show that bud-mutations have so far played a very small part in bringing into existence varieties of apples. The few varieties known to have come from bud-mutations differ from the sorts from which they sprang in so few particulars — chiefly in color — that it can be but doubtfully said that new varieties so originate. Would it not be better to call them strains or races?

Deviations from the type which can be perpetuated as a new race or variety of apples are exceedingly rare. In this fruit, so far as they have been studied, they represent only modifica-

[1] "*In an orchard owned by Van Sent & Wipple on Orcas Island, San Juan County, Washington, are fifty Gravenstein trees which have been bearing about ten years. On one of these, starting from the main trunk and about three feet from the ground, is a limb which from the time the tree commenced to bear, has produced beautiful red apples. We call the apple the Red Gravenstein, because it has the Gravenstein flavor, the Gravenstein shape, the Gravenstein core, and ripens at about the same time. In fact it is a Gravenstein in every way except color.*" *From a circular sent out by the Vineland Nursery Company, Clarkston, Washington,* 1911.

tions of existing characters. Of course, even so, they may furnish material for improvement, slight though it be. When a variation is found in an apple tree there must always be the question as to whether it is transmissible or merely a fluctuation due to the environment of the plant which will disappear with a change in the environment. We are wholly ignorant of the causes or of the conditions which give rise to mutations, although one may now hear provisional whispers as to how they originate. Their exceeding rarity as compared with the countless number of variations which are not transmitted through heredity, shows that varieties of apples, as of other fruits and most other plants propagated from vegetative parts, are wonderfully stable and practically continuous. This brings us to the subject of improving apples by bud-selection.

IMPROVING APPLES BY BUD-SELECTION.

The idea is current among experiment station workers, nurserymen and fruit growers that the apple, and other fruits as well, can be improved by bud-selection. It is held that the variations in fruit, tree, productiveness, vigor and hardiness to be found in varieties of fruit, can be reproduced by taking cions or buds from the plants possessing the variations. A number of fruit growers and nurserymen are putting this theory in practice and trees are now offered for sale with a "pedigree" to show that they came from known, good ancestry.

A study of the varieties of apples, grapes and plums[1] now grown gives no evidence, whatever, that any sort of these fruits has come into existence by continuous selection; that any variety has been improved, or that any variety has degenerated through the cumulative action of natural or artificial selection. No precise experimental evidence has been offered to prove that varieties of fruit can be changed in the least by continuous bud-selection. The trend of scientific thought is now overwhelmingly against the transmission of acquired characters, as most variations seem to be, and against continuous selection as a process of improving or changing plants grown from seeds, and would, if directed to bud-selection, be much more against this supposed means of improving plants.

[1] The histories of the best known varieties of these three fruits, so far as they can be learned, are given in the books on these fruits published by this Station.

The variability to be seen in all varieties of apples is due to changing environment — if we except the rare bud-mutations the causes of which are not known. Environmental changes produce manifold modifications in many of the characters of individual apple trees but there is nothing to show that such changes have any effects on varietal characters. These fluctuating variations appear when individuals of a variety have different environments; with a return to the same environment, they disappear. A Baldwin taken from New York to Virginia produces an apple different from the New York Baldwin; taken to Missouri, the Baldwin is still different; taken to Oregon, it is unlike any of the others. If trees are brought back from these states to New York, they become again New York Baldwins.

This discussion of variations, of necessity brief and primary, cannot be dismissed without calling attention to the great importance of further knowledge as to the origin and behavior of bud-mutations, the "sports" of the orchardist. The discovery of their origin, how to produce them, how to control them, might hasten immeasurably the progress of fruit-breeding. Are they the result of intrinsic or of extrinsic influences? If the former, we can only continue to search for them, taking what Nature chooses to give; but if they can be induced by extrinsic agencies, we might do much with them in improving fruits — in making plants evolve.

AN EXPERIMENT IN CROSSING APPLES.

The foregoing introduction prepares the way for the account of an experiment which now follows by calling attention: 1st. To the fact there has been little effort made so far to improve apples. 2d. That the apple has been, and probably can be, improved only by the introduction of new varieties. 3d. That while there is but little knowledge as to how varieties of apples have originated, yet it is probable that most of them have come from crossing varieties and that, therefore, hybridization is the best means of obtaining new varieties of apples and of improving this fruit.

The first task in discussing the experiment in hand, is to describe the material and the way it has been handled. This is done at some length, with the feeling that in the present state of fruit-breeding we need to know the manual of arms quite as much as the principles of war.

The material.— The material of the following discussion comes from 125 apple crosses growing on the grounds of the Geneva Station. The original number of seedlings was 148 of which 46 grew from crosses made at the Station in 1898 and 102 from crosses made in 1899, the comparatively small number of 23 having fallen by the wayside from seed-pan to fruiting age. The seedlings were grown in the greenhouse from plantings made the first year in March and the second year in February, the seeds having been stratified during the winter. The young trees were transplanted to nursery rows in the open as soon as weather permitted. Of the 125 crosses, but 106 have so far fruited.

Method of crossing.—A description of the method of crossing now in use, much the same when these crosses were made, may be of interest to fruit growers who have never performed the operation. The blossom of the apple, of course, needs no description other than to say it is a hermaphrodite — that is, both male and female organs are found in the same flower. In crossing, young flowers are chosen, on the plant selected as female parent, in which the anthers have not yet opened. The stamens bearing the anthers are removed with a sharp scalpel or small forceps. A few days later the stigma is pollinated with pollen from a flower of the plant selected to be the male parent. Accuracy is safeguarded by taking the pollen from a flower which has been protected by a paper bag. The treated flower is then enclosed in a paper bag to protect it from other pollen until seeds have set. After a week or two the paper bag is removed and one of cheesecloth substituted to remain as protection for the fruit until harvest. The greatest care must be exercised in making different crosses to have fingers and tools sterile, probably best accomplished by the use of alcohol before each operation. The pollinating should be done on a bright, sunny day.

Management of the trees in this experiment.— In the spring of 1901, under the direction of Professor S. A. Beach, then in charge of horticulture at this Station, the crosses were all top-worked in bearing trees in a variety orchard. These grafts began bearing in 1904 and have continued to come into bearing until the present year, all now living having borne some fruit. The grafting of the seedlings on bearing trees to hasten the production of fruit was very unsatisfactory and in breeding tree

fruits at Geneva now we do not graft. The objections are several: Some of the grafts do not take, others are blown out, others blight, and insects, plant lice in particular, have a propensity for devouring grafts as the choicest morsels to be found in a tree. The chief objection to this method is, however, that one learns little or nothing in regard to tree characters that is reliable — indispensable data for full knowledge of a cross either for scientific or for practical purposes. Lastly, it is "confusion worse confounded" to work with trees bearing several varieties of fruit because of the disorder in pruning, self-pollinating and harvesting.

Fortunately the seedling trees were left in the nursery rows after grafting wood had been removed. Here the writer found them in 1905, rather stunted from much crowding in the row, but still healthy, vigorous plants. In the spring of 1906 these trees were planted at distances of 8 feet in rows 8 feet apart where they are now standing. The first apples were borne in 1908, a few only of the crosses setting fruit. The plantation came into bearing very slowly and in June, 1910, the trees were all ringed with the result that all but 17 of the trees were fruitful in 1911. The 17 laggards are trees which either bore very heavily the preceding year, or had but a sprinkling of fruit which was blown off by one or another of two gales; or, as in the case of at least three trees, ill health and weakness may be the cause of nonfruiting.

Until 1911 the young trees were plowed and cultivated about as are commercial orchards in western New York. The tops of the trees were so interlaced in 1911 that team work in the orchard was stopped. To take the place of cultivation, a heavy mulch of straw manure was applied this year. The plantation has had the usual treatment for San José scale, apple scab and codling-moth. The pruning has been very light from the start — only crossed and dead branches having been removed in any season.

In this and in other experiments it has been found that ringing in June, taking out a section of bark an inch wide, a foot or thereabouts from the ground, seems to be a satisfactory method of hastening the bearing of apple trees. The operation with

these trees brought about the desired result and with no perceptible abnormality in tree or fruit.

Difficulty in securing a second generation.— In this experiment we have to deal, it is to be regretted, with only the first generation of hybrid offspring. This brings us to a difficulty we have had in working with these young trees. The great desirability of having the second generation has been recognized from the start and for several years efforts have been made to get selfed seeds from these crosses,— with the result that we have scarcely a score of their offspring. The maledictions of some demon seem to have been showered upon the selfing of these crosses in the shape of accidents, bad weather and holidays at critical times. But beside these fortuitous obstacles, it seems certain that it is rather more difficult to self blossoms on young, vigorous, floriferous apple trees than it is on older plants. One of the great difficulties in Mendelian work with apples, and other tree fruits, will be to obtain the second generation in sufficiently large numbers to give results than can be relied upon.

The crosses.— The crosses, with the number of each, are:—

Ben Davis X Esopus	4	Esopus X Jonathan	2
Ben Davis X Green Newtown	13	McIntosh X Lawver	1
Ben Davis X Jonathan	11	Ralls X Northern Spy	9
Ben Davis X McIntosh	11	Rome X Northern Spy	1
Ben Davis X Mother	20	Sutton X Northern Spy	5
Esopus X Ben Davis	29		

DESCRIPTION OF THE CROSSES.

The following is a tabulated description of the characters studied in these crosses. Unfortunately trees of the parents of the same age as the crosses were not available. The size and shape of the fruits of the parents and of the progeny can be compared in the plates. Those not familiar with the parents, all common varieties, can find full descriptions of them in *The Apples of New York*. Detailed descriptions of the newly named varieties are given on pages 479–486.

The abbreviations used in the table are as follows:

Shape of tree.— d, drooping; s, spreading; u, upright.

Form.— c, conical; o, oblate; ob, oblong; ov, ovate; r, roundish.

Color.— b, blush; c, carmine; d, dark; g, green; l, light; r, red; s, striped; y, yellow.

Flavor.— a, acid; s, sweet; sa, subacid.

TABLE I.—DESCRIPTION OF THE CROSSES IN APPLE BREEDING EXPERIMENT.

Number.	CROSS.	Height of tree.	Diameter of trunk.	Shape of tree.	Pounds of fruit in 1911.	Length of apples.	Width of apples.	Shape of apples.	Color of fruit.	Flavor.	Season.	Remarks.
		Feet	*Inches*			*Inches*	*Inches*					
18	Ben Davis × Jonathan.....	10	3.25	u. s.	79	2.06	2.62	o. c.	r. s.	sa.	Dec.–Feb.	Resembles Jonathan in shape, color and flesh characters.
19	Ben Davis × Jonathan.....	10	3.06	u. s.	80	2.25	2.62	o. c.	d. r.	s.	Nov.–Jan.	Resembles Jonathan in shape, size and flesh, but much darker in color.
20	Ben Davis × Jonathan.....	12	3.13	d.	88	2.31	2.75	o. c.	y. b.	sa.	Dec.–Mar.	Fruit resembles Jonathan more than Ben Davis.
21	Ben Davis × Jonathan.....	11	3.62	d.	109	2.56	2.50	ob. c.	d. r. s.	sa.	Dec.–Mar.	Resembles Ben Davis externally and internally, but more highly colored.
22	Ben Davis × Jonathan.....	11	2.94	u. s.	30	2.31	2.62	r. tr.	d. r.	sa.	Nov.–Feb.	Of the Jonathan type, but darker in color and inferior in flavor.
23	Ben Davis × Jonathan.....	10	3.	s.	40	2.31	2.87	o. c.	r. s.	sa.	Dec.–Feb.	In shape like Jonathan, but larger and more conic, with Ben Davis color.
24	Ben Davis × Jonathan.....	10	3.25	u. s.	94	2.	2.50	r. o.	d. r.	sa.	Dec.–Feb.	Of the Jonathan type, though smaller.
25	Ben Davis × Jonathan.....	10	3.13	u. s.	47	2.25	2.62	r. o. c.	d. r.	s.	Dec.–Mar.	Resembles Jonathan but is more conic, much inferior in flavor.
26	Ben Davis × Jonathan.....	9	3.75	s.	70	2.50	2.69	r. ob. c.	y. b. r.	sa.	Jan.–Mar.	Externally like Ben Davis; flesh like Jonathan; inferior in flavor.
27	Ben Davis × Jonathan.....	12	3.87	u.	39	2.31	2.75	r. o. c.	d. r.	sa.	Nov.–Feb.	Of the Jonathan type both externally and internally, but more highly colored.
28	Ben Davis × Jonathan.....	10	3.50	s.	65	2.62	2.75	r. c.	y. b. r. s.	sa.	Dec.–Feb.	Resembles Jonathan externally and internally. Named Rensselaer.
40	Ben Davis × Mother.......	10	3.06	u.	69	2.44	2.94	r. c.	d. r.	sa.	Nov.–Feb.	Resembles Ben Davis in shape; darker than parents in color.
41	Ben Davis × Mother.......	10	2.62	u.	40	2.31	2.69	r. c.	d. r.	s.	Nov.–Jan.	Resembles Mother in all characters excepting cavity and basin which are those of Ben Davis.
42	Ben Davis × Mother.......	7	2.31	s.	21	2.37	2.75	r. o. c.	d. r. s.	s.	Nov.–Jan.	Very similar to Mother.
43	Ben Davis × Mother.......	6	1.69	s. d.	2	2.69	2.75	r. c.	d. r.	sa.	Nov.–Jan.	Like Ben Davis in shape, but resembles Mother in color and flesh characters.

44	Ben Davis × Mother.......	10	2.94	u. s.	45	2.50	2.56	r. c.	d. r. s.	sa.	Jan.-Apr.	Of the Mother type though more conic; quality very inferior.
45	Ben Davis × Mother.......	8	2.94	s.	53	1.94	2.25	r. c.	r. s.	sa.	Dec.-Feb.	Resembles Ben Davis in color, shape and flesh, but is smaller.
46	Ben Davis × Mother.......	10	3.25	u.	20	2.	2.50	r. c.	l. r. c.	s.	Dec.-Feb.	Intermediate between Mother and Ben Davis in shape; color of Mother.
47	Ben Davis × Mother.......	8	3.19	u. s.	48	2.81	2.87	r. o.	d. r. s.	sa.	Nov.-Jan.	Resembles Mother in color, cavity, stem, flesh and shape.
48	Ben Davis × Mother.......	9	2.94	s.	31	2.50	2.87	r. o.	d. r. c.	sa.	Nov.-Dec.	Shape, cavity, stem and color are those of Mother; flesh intermediate.
49	Ben Davis × Mother.......	11	3.75	u.	92	2.37	2.50	r. c.	d. r. c.	s.	Nov.-Jan.	Shape that of Ben Davis; color and flesh that of Mother.
50	Ben Davis × Mother.......	9	2.37	u. s.	20	2.50	2.87	r. c.	d. r. s.	s.	Dec.-Feb.	Size, shape and color of Ben Davis; cavity of Mother.
51	Ben Davis × Mother.......	9	2.94	u.	70	2.31	2.62	r. ob. c.	r. s. c.	sa.	Dec.-Mar.	Type of Ben Davis in shape and color, though darker; flesh of Mother.
52	Ben Davis × Mother.......	8	2.62	s. d.	47	2.75	2.87	r. ob. c.	r. s.	sa.	Nov.-Jan.	Type of Ben Davis externally and internally; more mottled in color.
53	Ben Davis × Mother.......	8	2.62	s. d.	76	2.50	2.75	r. o. c.	r. s.	a.	Dec.-Mar.	Very similar in shape, color, flesh and flavor to Ben Davis, but smaller.
54	Ben Davis × Mother.......	8	2.13	u. s.	19	2.25	2.87	o. c.	r. c.	s.	Dec.-Jan.	Of the Mother type except in taste, which is that of Ben Davis.
55	Ben Davis × Mother.......	11	3.75	u. s.	6	2.06	2.62	o.	l. r.	s.	Jan.-Mar.	Shape of Mother, but cavity, color, flesh and stem all those of Ben Davis.
56	Ben Davis × Mother.......	12	3.87	u.	64	2.94	3.25	r. c.	l. r. c.	sa.	Nov.-Jan.	Size, shape and flesh resemble Ben Davis. Named Schenectady.
57	Ben Davis × Mother.......	9	3.13	u. s.	68	2.37	2.62	r. c.	r. s. c.	sa.	Dec.-Feb.	Type of Mother though brighter in color and with flavor of Ben Davis.
58	Ben Davis × Mother.......	10	2.87	u. s.	33	2.19	2.75	r. o. c.	d. r. c.	s.	Nov.-Jan.	Intermediate between Ben Davis and Mother in shape; like Mother in other characters.
102	Sutton × Northern Spy.....	12	3.50	u.	3	2.50	3.13	r. o. c.	y. d. b.	sa.	Dec.-Mar.	Like Spy in size, shape, flesh and flavor, but yellow in color.
103	Sutton × Northern Spy.....	12	3.37	u.	1	2.62	3.	o. c.	d. r. s.	sa.	Dec.-Feb.	Like Spy in shape and color, but not flavor; red.
104	Sutton × Northern Spy.....	10	3.31	u. s.	20	2.56	3.	r. o. c.	d. r.	sa.	Dec.-Mar.	Shape and size of Sutton; ribbed like Spy and flesh of Spy.
105	Sutton × Northern Spy.....	11	3.37	u. s.	24	2.62	3.31	r. c.	d. r. s.	sa.	Dec.-Apr.	Resembles Spy in shape, flesh, flavor and size, but brighter in color. Named Oswego.
101	Rome × Northern Spy.....	10	3.50	u. s.	91	2.31	2.94	r. o.	y. b.	sa.	Jan.-May	Resembles Rome in shape; flesh of Spy; unlike either in color.
92	Ralls × Northern Spy......	11	3.19	u. s.	40	2.	2.56	o. c.	l. r.	sa.	Nov.-Feb.	Resembles Ralls more nearly than Spy in all characters.

TABLE I.—DESCRIPTION OF THE CROSSES IN APPLE BREEDING EXPERIMENT — *Continued.*

Number.	CROSS.	Height of tree.	Diameter of trunk.	Shape of tree.	Pounds of fruit in 1911.	Length of apples.	Width of apples.	Shape of apples.	Color of fruit.	Flavor.	Season.	Remarks.
		Feet	*Inches*			*Inches*	*Inches*					
93	Ralls × Northern Spy......	10	2.75	u. s.	14	2.13	2.75	o.	d. r.	sa.	Dec.–Apr.	Resembles Ralls in all characters excepting shape, which is more like Spy.
94	Ralls × Northern Spy......	12	4.	u. s.	29	2.75	3.	r. ob. c.	d. r. s.	sa.	Nov.–Mar.	Of Northern Spy type, shape, color, flesh and flavor; named Schoharie.
95	Ralls × Northern Spy......	11	3.25	u. s.	21	2.31	2.62	o. c.	d. r.	sa.	Jan.–Apr.	Fruit resembles Ralls externally and internally.
96	Ralls × Northern Spy......	9	3.	u. s.	49	1.69	2.83	r. c.	y. b.	sa.	Dec.–Mar.	Type of Ralls in all characters.
97	Ralls × Northern Spy......	10	2.87	u. s.	50	2.25	2.56	r. c.	d. r. c.	sa.	Jan.–Apr.	Resembles Ralls but is more conic; ribbed like the Spy.
98	Ralls × Northern Spy......	9	2.06	u. s.	58	1.87	2.25	o. c.	r. s.	sa.	Jan.–Apr.	Resembles Ralls very closely but not as highly colored.
99	Ralls × Northern Spy......	10	3.25	u. s.	29	2.31	2.75	r. o. c.	r. s.	sa.	Dec.–Feb.	Resembles Northern Spy, though less ribbed and brighter in color.
100	Ralls × Northern Spy......	9	2.75	u.	32	1.31	2.50	o. c.	d. r.	sa.	Dec.–Mar.	Type of Ralls except in flavor, which is that of Spy.
1	Ben Davis × Esopus.......	10	3.25	u. s.	41	2.31	2.56	r. c.	d. r.	sa.	Dec.–Feb.	Type of Ben Davis, but duller and less striped in color.
2	Ben Davis × Esopus.......	11	3.06	u. s.	14	2.56	3.13	r. o. c.	d. r. b.	sa.	Dec.–Feb.	Resembles Esopus in shape, but has flesh of Ben Davis; unlike either in color.
3	Ben Davis × Esopus.......	10	3.25	u. s.	85	1.87	2.37	r. o.	y. d. b.	sa.	Dec.–Feb.	Like Esopus in shape, color and flesh characters. Smaller than either parent.
4	Ben Davis × Esopus.......	11	3.19	u. s.	54	2.87	2.87	ob. c.	t. r. c.	sa.	Dec.–Mar.	Resembles Ben Davis in size and shape, but Esopus in color and flesh.
29	Ben Davis × McIntosh.....	10	3.31	u. s.	85	2.25	2.87	o. c.	r. c.	sa	Dec.–Feb.	Like McIntosh in shape, but duller in color and has flesh of Ben Davis.
30	Ben Davis × McIntosh.....	10	3.25	u. s.	36	2.25	2.75	o. c.	r. s.	s.	Nov.–Feb.	Resembles McIntosh externally; Ben Davis internally.
31	Ben Davis × McIntosh.....	10	2.56	s. d.	43	2.50	2.81	r. c.	y. b. r.	sa.	Dec.–Mar.	In all characters more like Ben Davis than McIntosh.

32	Ben Davis×McIntosh.....	10	2.75	u. s.	10	2.	2.37	r. o. c.	d. r. s. c.	sa.	Nov.-Jan.	Resembles M Intosh outwardly and Ben Davis inwardly.
33	Ben Davis×McIntosh.....	12	3.50	u. s.	36	2.81	3.06	ob. c.	y. b.	s.	Oct.-Jan.	Has shape of Ben Davis, but the clear white flesh of McIntosh; yellow.
34	Ben Davis×McIntosh.....	8	2.75	d.	45	2.50	3.13	r. o.	d. r. s. c.	sa.	Nov.-Feb.	Very similar to McIntosh in all characters. Named Cortland.
35	Ben Davis×McIntosh.....	8	2.13	u.	3	2.37	2.75	r. c.	b. d. r.	sa.	Nov.-Jan.	Similar to McIntosh but more conic and flesh yellower. Named Onondaga.
36	Ben Davis×McIntosh.....	9	3.25	u.	67	2.25	2.75	r. o. c.	d. r.	sa.	Nov.-Feb.	Like McIntosh in shape and color, but resembles Ben Davis in cavity, basin and flesh.
37	Ben Davis×McIntosh.....	10	3.31	u. s.	68	2.13	2.31	r. ob. c.	d. r. s.	sa.	Nov.-Feb.	Like Ben Davis in shape and flesh, but has the color of McIntosh. Named Otsego.
38	Ben Davis×McIntosh.....	11	3.19	u. s.	12	2.56	2.87	r. c.	y. b.	sa.	Nov.-Mar.	Type of Ben Davis in shape, size and flesh; unlike either parent in color.
39	Ben Davis×McIntosh.....	10	2.81	u.	43	2.69	2.87	r. ob.	y. b. r.	sa.	Nov.-Jan.	Like Ben Davis in shape, but the McIntosh in flesh and flavor; unlike either in color.
5	Ben Davis×Gr. Newtown..	9	3.31	u. s.	75	2.25	2.94	r. o. c.	y. b. s. c.	sa.	Dec.-Feb.	In shape, size, flesh and flavor like Newtown; color similar to Ben Davis. Named Clinton.
6	Ben Davis×Gr. Newtown..	12	3.25	u.	36	2.06	2.75	o.	d. r.	s.	Nov.-Feb.	In shape like Green Newtown; in color and flesh like Ben Davis.
7	Ben Davis×Gr. Newtown..	12	3.	u. s.	57	2.62	2.87	o. c.	y. b.	sa.	Jan.-Apr.	In outward appearance like Newtown, but flesh like Ben Davis.
8	Ben Davis×Gr. Newtown..	12	3.25	u.	41	2.81	3.	r. c.	d. r.	sa.	Nov.-Jan.	Resembles Ben Davis in size, color, flesh, characters and flavor.
9	Ben Davis×Gr. Newtown..	12	3.50	u.	8	2.56	2.81	r. ob. c.	d. r.	s.	Jan.-Apr.	Resembles Ben Davis, darker in color and is sweet in flavor.
10	Ben Davis×Gr. Newtown..	10	3.	u. s.	23	2.	2.62	o. c.	d. r. s. c.	sa.	Dec.-Apr.	Resembles Newtown in all characters excepting color, which is more like Ben Davis.
11	Ben Davis×Gr. Newtown..	11	3.31	u.	25	2.50	2.87	r. o. c.	y. b.	sa.	Jan.-Apr.	Resembles Newtown outwardly and inwardly.
12	Ben Davis×Gr. Newtown..	10	3.06	u. s.	79	2.25	2.75	r. o.	y. b.	sa.	Jan.-Apr.	Resembles Newtown in all characters excepting flavor.
13	Ben Davis×Gr. Newtown..	11	3.62	u. s.	97	2.62	3.	r. c.	y. b. r.	sa.	Nov.-Jan.	Resembles Ben Davis in color and flesh, otherwise more like Newtown. Named Westchester.
14	Ben Davis×Gr. Newtown..	9	3.13	s.	64	2.56	3.	o. c.	d. r. s. c.	s.	Nov.-Jan	In shape, basin and flesh like Ben Davis; cavity like Newtown, color unlike either.
15	Ben Davis×Gr. Newtown..	12	3.75	u. s.	70	2.56	3.13	r. o. c.	b. r.	sa.	Jan.-Apr.	Resembles Ben Davis, but more oblate, more highly colored, better flavor. Named Saratoga.

TABLE I.—DESCRIPTION OF THE CROSSES IN APPLE BREEDING EXPERIMENT — *Concluded.*

Number.	Cross.	Height of tree.	Diameter of trunk.	Shape of tree.	Pounds of fruit in 1911.	Length of apples.	Width of apples.	Shape of apples.	Color of fruit.	Flavor.	Season.	Remarks.
		Feet	*Inches*			*Inches*	*Inches*					
16	Ben Davis×Gr. Newtown.	10	3.13	u. s.	50	2.25	2.75	r. o.	y. b. s. r.	sa.	Jan.–Mar.	Type of Newtown, but red.
60	Esopus×Ben Davis	11	3.19	u. s.	80	2.37	2.75	r. c.	l. r. s. c.	sa.	Dec.–Mar.	In shape, size and color like Esopus, with flesh of Ben Davis.
61	Esopus×Ben Davis	11	3.37	u. s.	43	2.31	2.50	ob. c.	d. r. s. c.	s.	Dec.–Mar.	Shape of Ben Davis, but the cavity, color and flesh like Esopus.
62	Esopus×Ben Davis	9	2.56	u.	2	1.87	2.56	o.	d. r. s.	sa.	Jan.–Mar.	Resembles Esopus more than Ben Davis in all characters.
63	Esopus×Ben Davis	13	3.87	u.	35	2.31	2.87	r. o. c.	d. r.	sa.	Dec.–Feb.	Resembles Esopus in all characters excepting flavor which is more like Ben Davis.
64	Esopus×Ben Davis	12	2.75	u.	9	2.50	2.94	r. c.	y. b.	a.	Nov.–Feb.	Like Ben Davis in shape, but Esopus in flesh characters; unlike either in color.
65	Esopus×Ben Davis	8	2.75	s. d.	6	2.75	2.25	o. c.	y. l. r.	s.	Nov.–Mar.	Unlike either parent in size, shape or color; flesh like Esopus.
66	Esopus×Ben Davis	11	3.25	u.	49	2.50	2.69	r. c.	d. r.	sa.	Dec.–Mar.	Type of Ben Davis, but more highly colored and more like Esopus in flavor.
67	Esopus×Ben Davis	10	3.	u. s.	55	2.62	2.75	r. ob. c.	d. r. s.	sa.	Nov.–Jan.	Very much like Ben Davis in all characters.
68	Esopus×Ben Davis	12	4.	u. s.	27	2.62	3.25	r. o.	y. b.	sa.	Jan.–Mar.	Much like Ben Davis in all characters, but more oblate.
69	Esopus×Ben Davis	....	....	....	1	2.25	2.62	r. o.	l. r. s.	s.	Nov.–Jan.	Resembles Esopus in color, cavity and flesh; like Ben Davis in shape.
70	Esopus×Ben Davis	7	2.06	u. s.	4	2.37	2.62	r. o. c.	y. b. l. r.	sa.	Nov.–Jan.	Like Ben Davis in shape, flesh; unlike either parent in color.
71	Esopus×Ben Davis	11	3.25	u. s.	69	2.62	2.62	r. c.	d. r.	sa.	Dec.–Feb.	Like Ben Davis in all characters.
72	Esopus×Ben Davis	11	3.25	u. s.	42	2.87	2.50	r. c.	d. r.	sa.	Dec.–Mar.	Resembles Ben Davis in size and shape, but with color, cavity and flesh characters of Esopus.
73	Esopus×Ben Davis	10	3.75	u. s.	67	2.25	3.	o.	d. r.	sa.	Nov.–Jan.	Resembles Esopus in all characters excepting shape, which is intermediate.

74	Esopus×Ben Davis	9	1.75	u.	3	1.81	2.06	r. c.	y. b.	sa.	Jan.–Mar.	Resembles Esopus, but less well colored and smaller.
75	Esopus×Ben Davis	12	3.	u. s.	14	2.31	2.81	o. c.	r. s. c.	sa.	Dec.–Apr.	Of Ben Davis type externally; Esopus internally.
76	Esopus×Ben Davis	11	3.62	u. s.	74	2.06	2.37	a. c.	d. r.	sa.	Nov.–Mar.	Shape of Ben Davis, but smaller; color and flesh of Esopus.
77	Esopus×Ben Davis	12	2.62	u. s.	16	1.87	2.25	o. c.	d. r.	sa.	Jan.–Apr.	All characters resemble those of Esopus; smaller.
78	Esopus×Ben Davis	11	3.06	u. s.	30	2.06	2.50	ov. c.	b. r.	s.	Dec.–Mar.	Resembles Ben Davis in all characters; stem very long.
79	Esopus×Ben Davis	8	2.87	u.	56	2.50	2.87	r. o. c.	d. r.	sa.	Jan.–Apr.	Externally like Esopus; internally like Ben Davis.
80	Esopus×Ben Davis	10	3.06	s. d.	35	2.81	2.87	r. c.	d. r.	sa.	Dec.–Feb.	Shape, color and size like Ben Davis, but more conic; flesh and flavor that of Esopus.
81	Esopus×Ben Davis	7	2.37	s.	2	2.62	2.87	r. o. c.	y. b.	s.	Dec.–Feb.	All characters more like Esopus; ribbed and irregular.
82	Esopus×Ben Davis	10	2.50	u. s.	8	2.25	2.50	r. c.	d. r.	sa.	Dec.–Mar.	Characters like those of Esopus; smaller and darker in color.
83	Esopus×Ben Davis	10	2.87	u. s.	37	2.19	2.50	r. c.	y. b. r.	sa.	Dec.–Mar.	Outwardly like Ben Davis; inwardly like Esopus.
84	Esopus×Ben Davis	8	2.69	u.	23	2.	2.75	o. c.	d. r.	sa.	Jan.–Apr.	Characters those of Esopus, but smaller.
85	Esopus×Ben Davis	10	3.25	s. d.	9	2.62	3.	r. o. c.	d. r.	sa.	Dec.–Feb.	Like Esopus in shape, but in cavity, basin and flesh resembles Ben Davis.
86	Esopus×Ben Davis	8	2.50	s. d.	11	2.50	2.75	r. c.	d. r. s.	s.	Nov.–Jan.	In shape like Ben Davis; in color and flesh like Esopus; small and with poor flavor.
87	Esopus×Ben Davis	9	3.25	s. d.	6	2.50	2.62	r. c.	d. r.	s.	Nov.–Jan.	Shape, color and flesh like Esopus; basin and calyx resemble Ben Davis.
89	Esopus×Jonathan	11	3.25	u. s.	18	2.25	2.69	o. c.	d. r.	sa.	Dec.–Mar.	Resembles Esopus in all characters.
90	Esopus×Jonathan	10	2.62	u. s.	1	1.75	2.25	o.	d. r.	sa.	Dec.–Apr.	Resembles Esopus in all characters; smaller.
91	McIntosh×Lawver	10	4.	u. s.	85	2.13	2.81	r. o. c.	y. b. r.	sa.	Nov.–Feb.	Resembles McIntosh in all but color which is like Lawver, but more yellow.
59	Ben Davis×Mother							r. o.	d. r. s. c.	sa.	Nov.–Jan.	Resembles Ben Davis in all fruit characters excepting quality. Named Rockland.
106	Sutton×Northern Spy					2.75	2.13	o. c.	y. b.	sa.	Dec.–Mar.	Resembles Northern Spy except in color, being yellow. Named Tioga.
17	Ben Davis×Gr. Newtown							r. ob. c.	r. s. c.	sa.	Dec.–Mar.	Resembles Ben Davis externally and internally. Named Herkimer.
88	Esopus×Ben Davis							o.	y. b. l. r.	sa.	Dec.–Mar.	Color of Ben Davis, shape of Esopus. Named Nassau.

GENERAL CONSIDERATIONS.

Reversions.—A striking contradiction to the idea handed down from a remote age that seedling apples "throw back" to the wild prototype and are almost always worthless and degenerate fruits, is brought out in these crosses. The belief in "reversion" is so strongly ingrained in the minds of fruit growers that the term "seedling" is usually one of condemnation. Reversion in the sweeping way it was formerly used, is, in the light of present knowledge, a very misleading term. Nothing is more apparent in examining the fruit and trees under consideration than that they have inherited the characters of their immediate parents. This is so markedly true that in the great majority of the offspring, one acquainted with the parents of the several crosses can from tree and fruit tell the two parents. Ben Davis and McIntosh, for example, show in all of the apples into which they entered. Reversions to remote ancestors may occur, so we are now taught, as the bringing together of complementary factors which had become separated from one another. Such reversions were not apparent in these trees. Contrary to "throwing back" to wild apples, these crosses, in tree or fruit, were quite the equal of any similar number of named varieties, a fact to which many fruit growers can attest, who in the summer of 1911 saw and admired the fruit and trees.

Vigor increased by hybridity.— The stimulus of hybridity seems to be very marked in the vigor of these crosses. In spite of over-crowding in the nursery row for two or three years these trees are exceptionally strong in growth. In the same block are a few selfed Hubbardstons which are much weaker in growth. On another part of the farm are selfed Baldwins also averaging much weaker. These may be but coincidences but the facts are set down for what they are worth. A study of the descriptions of the fruits and of the plates will show that in the majority of the crosses the apples average larger than in either parent. The trees, too, are remarkably productive, a fact brought out by the weights of fruit given in the tabular descriptions.

Table II contains data for the comparison of height of tree, diameter of trunk and quantity of fruit in 1912, from these crosses and from four selfed Hubbardstons. The number of

trees in some of the progenies is too small to make the data very valuable but yet the figures are interesting and suggestive.

TABLE II.— AVERAGE HEIGHT OF TREE, DIAMETER OF TRUNKS, AND QUANTITY OF FRUIT.

CROSSES.	Number of trees.	Height of trees.	Diameter of trunks.	Quantity of fruit.
		Feet.	*Inches.*	*Pounds.*
Ben Davis × Esopus	4	10.5	3.1	48.5
Ben Davis × Green Newtown	13	10.8	3.2	50.4
Ben Davis × Jonathan	11	10.4	3.3	67.3
Ben Davis × McIntosh	11	9.8	2.9	40.7
Ben Davis × Mother	20	9.1	2.8	43.3
Esopus × Ben Davis	29	10.0	2.9	32.0
Esopus × Jonathan	2	10.5	2.9	9.5
McIntosh × Lawver	1	10.0	4.0	85.0
Ralls × Northern Spy	9	10.1	3.0	35.7
Rome × Northern Spy	1	10.0	3.5	91.0
Sutton × Northern Spy	5	11.2	3.3	12.0
Hubbardston (Selfed)	4	8.2	2.6	.5

Prepotency.— In the past, horticulturists, in common with breeders of other plants, and of animals as well, have designated certain individuals, varieties in the case of fruits, as "prepotent." Prepotency could be ascribed much more naturally to individuals before it was known that characters are quite independent in transmission, although there is still question in some quarters as to whether potency is a property of a unit character or of all the characters in an individual. Thus because of the great number of their named offspring we have commonly thought the Ben Davis, Fameuse, Oldenburg and Blue Pearmain, as examples, to be "prepotent." In the light of present information it is very doubtful if such prepotency exists in the sense of ability to impress all characters on the offspring.

It is generally agreed, though, that prepotency exists as to characters — that is, that there are marked variations in potency. Accepting this as a fact it must be conceded at once that a variety of apples may be prepotent in two or more characters which may be transmitted to the progeny quite independently of each other. If such be the case we should expect the offspring of some crosses of apples to resemble one parent more than the

other. It would seem that in Ben Davis crosses, Ben Davis characters most largely crop out. The progeny in crosses with Ben Davis, more often than not, have a Ben Davis aspect. Whether this is due to prepotency in one or more characters or to the fact that most of the characters in Ben Davis are a little off the ordinary — particularly striking — and because of this distinctness dominate in the appearance of the Ben Davis crosses, cannot be said.

We cannot prove from the behavior of these crosses that the varieties of apples involved are prepotent in any of their characters, but such prepotency is strongly suggested. In breeding work with grapes, raspberries and strawberries on the Station grounds, where many times as many crosses and plants have been under observation, we are more certain that varieties are prepotent in some characters. Such, too, is thought to be the case by workers with other plants and it has long been held by breeders of animals that individuals were "prepotent," which, if true, in light of present knowledge, probably means that there was prepotency in one or more characters of the animals. Knowledge regarding prepotency is a great desideratum in apple-breeding. The improvement of this fruit will go on much more rapidly, if we can select varieties for crossing which have the desired characters in greatest potency.

MENDELIAN INHERITANCES IN APPLES.

No study of heredity at the present time is worthy the name unless it take in consideration the laws brought out by Mendel and his followers. By aid of these laws in this experiment we are enabled to focus ideas which otherwise would have been dim, to give value to facts which a few years ago would have been worthless, and to see clues running through the work which without Mendel's discovery would have remained hidden.

It had not been the intention to discuss Mendelian inheritance in these crosses until we could add the testimony of the F_2 generation. That time seems at the very least a decade off and it is thought best to see what, if anything, can be learned from the F_1 progeny. It must be remembered that since apples are propagated by budding or grafting, a variety always possesses

its hereditary characters in the same state — a given character is permanently either homozygous or heterozygous. Therefore, the results obtained in these crosses are to be expected whenever the same varieties are crossed. Hence the F_2 generation is not so necessary in breeding apples as with plants grown from seed.

The reader must keep in mind, however, that there may be several explanations of the behavior of characters in the first generation following a cross and that the crucial test of whatever hypotheses are set forth as regards the characters in these hybrid apples is the behavior in the subsequent generations. Attention must be called, too, though scarcely necessary to one having knowledge of even the rudiments of genetics, to several sources of error in this experiment. Thus, the number of hybrid offspring of these crosses is so small that it is not probable that all of the possible combinations of the different kinds of germ cells are to be found even in the crosses having the largest progenies. Again, the work is vitiated somewhat by the fact that the total progenies of the several crosses have not been under observation, 23 out of 148 or about 15 per cent of the total number, having succumbed to the accidents which befall seedling plants, there being, however, no selection by the hand of man. Lastly, we are working with material of unknown parentage.

The characters of the apple chosen for consideration are those most important to apple growers; namely, color of skin, color of flesh, shape, size and acidity.

Color of skin.— The colors of apples may be roughly divided into five classes; yellow, yellow with a light red blush, yellow with one-third to one-half its surface overlaid with red, nearly solid red, and reddish black. The apples in these crosses contain only three colors, yellow, red and the intermediates between these. Whether the distribution of the intensity of color depends upon a complex or a simplex of unit characters, is at present impossible to determine. Unknown factors play too large a part to permit of an easy determination. Thus, we do not know exactly the nature of color; the amount of color in a variety depends largely upon the soil and the method of orchard management; and, we are working with material of unknown parentage. But if we can state roughly how the color is inherited in a few

leading varieties, the knowledge should be of value for either identical or other crosses. From a study of all the material, we may hazard the following provisional statements:

First, the fruits in which yellow predominates over red are in a heterozygous condition for yellow and red; second, the fruits in which red predominates are either homozygous or heterozygous; third, the pure yellows are recessive and consequently are homozygous. These conclusions are drawn from the following data.

In the Ben Davis X Jonathan progeny,[1] we have eleven seedlings, all red or nearly red. The yellow portion of these apples is so meager as not to arouse suspicion of a heterozygous condition. The assumption that there is no yellow in Ben Davis or Jonathan is supported by the results in other crosses in which one of these varieties was a parent. If, however, red consists of a complex of unit characters — the very light red being the simple unit character and the dark red a multiple of red unit characters, then, of course, it is impossible to tell from these few individuals whether yellow is or is not a recessive in this cross. For example, red would have to consist of only three unit characters to require sixty-four individuals to give one yellow. It would not be surprising if the red color in apples consists of more than one unit for red, since in other plants color is often composed of more than one unit character. Thus, Nillson-Ehle[2] separated two distinct blacks in his study of the inheritance of black color in the glumes of oats, and three distinct, inheritable reds in a red Swedish wheat. East[3] found two yellow colors in the endosperm of yellow corn, "each behaving when crossed with its absence, as an independent allelomorphic pair." If one yellow in corn gives a light yellow appearance, it is not unreasonable to expect that one red in apples may give a very light red and a complex of red unit factors a dark red. The only method of determining this point is, of course, by segregating the unit factors in future generations.

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[1] The first name in all cases is the maternal parent and the second the paternal.

[2] Nillson-Ehle, H., 1909, "Kreuzungsuntersuchungen an Hafer und Weizen," Lunds Universitets Arsskrigt, N. F.; Afd. 2, Bd. 5, Nr 2, 1–122.

[3] East, E. M., 1910, "A Mendelian Interpretation of Variation that is Apparently Continuous", *Am. Nat.* 44: 65–82.

In the Ben Davis X Mother apples there are seventeen apparently pure reds and three individuals evidently heterozygous for yellow and red. These three heterozygous apples might, however, under different circumstances, as for instance with a longer season and more favorable soil conditions, develop a more intense red, or in accordance with the assumption made, they may contain a red which is less complex in organization than that of their sisters.

The Sutton X Northern Spy progeny furnishes five individuals, three of which are classed as red and two as yellow. This segregation indicates Mendelian splitting, though the numbers are too few to more than suggest that the red is dominant and the yellow recessive. The yellow individuals, however, may not be pure recessives for a light reddish tinge was present on a few specimens of both trees. Does this reddish tinge signify that red individuals will appear in future generations if the variety be selfed, or is the red due to some physiological condition? Certain varieties, as the Yellow Transparent and Early Ripe, do not have this very light blush of red or bronze, but among all of our present crosses, no true yellows have appeared. Although we do not know whether one unit of red is contained in these yellow individuals, we suspect that both Sutton and Northern Spy must carry yellow as a recessive. This view is substantiated by the fact that in the other crosses in which Northern Spy is a participant, heterozygous individuals appear which evidently carry yellow.

The Rome X Northern Spy produced only one seedling and this is classified as an intermediate in color.

Ralls X Northern Spy gave nine seedlings, seven of which are classified as red, and two as heterozygous for red and yellow. It is probable from this cross that Ralls does not carry yellow as a simple unit character, for if it did, yellow individuals should have appeared.

Ben Davis X Esopus gave three red and one heterozygous red, and the reciprocal cross gave the same two classes, but in the proportion of eighteen to eleven. The difference in the ratios for these two crosses is, of course, of no significance, owing to the few individuals in the first. As there was no evidence of a re-

cessive yellow in the eleven individuals of Ben Davis X Jonathan, one can assume that the Esopus in the Ben Davis and Esopus cross, is responsible for the yellow color.

Esopus X Jonathan gave two reds, in which the red was predominant. From so few individuals one can draw no conclusion, yet the findings substantiate the statements made that Jonathan does not carry yellow.

McIntosh is evidently a carrier of yellow, for in the McIntosh X Lawver — the male being the very dark red — one heterozygous individual is produced, and in the Ben Davis X McIntosh seedlings — Ben Davis probably not carrying yellow as has been previously noted — there are eight apparently pure reds and three individuals heterozygous for red and yellow.

Ben Davis X Green Newtown is an interesting cross. The maternal parent is supposedly a pure red and the paternal parent is yellow with a very light red blush. In the segregation of red and yellow, providing the former is dominant to the latter, the ratio expected would be one pure red to one heterozygous red. Eight reds and five yellowish reds or heterozygous individuals are obtained, the expected classes appearing, but not in a 1:1 ratio.

The distribution of skin color, whether in the form of stripes or solid colors, cannot be expressed in Mendelian terms. The solid and blushed individuals appeared as follows: Ralls X Northern Spy one solid, Ben Davis X McIntosh two blushed, Ben Davis X Green Newtown and Sutton X Northern Spy, one blush from each cross. All of the remaining seedlings produced fruit striped and mottled in various degrees.

Color of flesh.— In flesh colors, though a resemblance to either one of the parents or to an intermediate condition is found in all the individuals, the most marked differences are found in the Ben Davis X McIntosh progeny. This would be expected since McIntosh has a very characteristic white flesh. In the eleven Ben Davis X McIntosh apples, six resemble Ben Davis in flesh color, two are intermediate and three are distinctly McIntosh whites. From so few numbers and because of the lack of knowledge of the parents of these varieties, it is hardly possible to give the gametic constitution of color. If, however, one combines the six Ben Davis colors and the two intermediates, it can

be assumed that both Ben Davis and McIntosh carry yellow and white, the white being recessive. This assumption would give nine yellows to three whites and there are eight yellowish individuals to three whites. From the general appearance of the McIntosh flesh, one would think it to be homozygous for white. However, it is not impossible to believe that the yellow is present and that the factor necessary for its development is lacking.

Size and shape.— It promises to be a difficult problem to determine inheritance of size and shape in apples. Castle has found size to be an intermediate character in his study of the inheritance of size in rabbits, and East has found parents of different sizes in maize to produce ears of intermediate length and kernels of intermediate size. The intermediates or F_1 generation in the maize produced progeny which varied in size from the small to the large parent, while the F_1 generation of rabbits produced only offspring of intermediate size. It may be suspected, therefore, that fruits likewise produce intermediate individuals. However, if size and shape consist of a complex of unit characters, it will be very difficult to determine whether they are bred as intermediates or not, for to so ascertain would require the production of thousands of individuals to obtain all the possible combinations of a complex of five or six units. Size and shape of fruits depend upon at least length and breadth measurements — not mentioning such unknown factors as nutrition, fertilization of the ovules and the like. With these unknown factors and in consideration of the meager data, we can draw but the roughest conclusions as to the inheritance of these characters.

Ben Davis X Mother gave six individuals which resemble the mother parent, four that are classed as intermediates and ten which bear paternal characteristics as to shape and size. This classification does not signify that the offspring are exactly like either one of the parents but that the majority of the characters are more like one parent than the other, and consequently bear a closer resemblance to the one than to the other. In this cross none of the twenty seedlings were much inferior or much superior to either parent in size. The size and shape of these crosses are shown in Plates XLVII, XLVIII, XLIX.

A slightly greater variation occurred in the eleven Ben Davis X Jonathan progeny. Ben Davis X Jonathan gave nine individuals with marked Jonathan characteristics and two with distinct Ben Davis characteristics, as shown in Plates L and LI.

Sutton X Northern Spy produced three individuals of marked paternal shape, one intermediate and one listed as maternal in general appearance. Four of these individuals gave larger fruits than either parent. This increase in size may be due to a heterozygous condition, which would probably stimulate the production of flesh tissue. These apples are shown in Plate LII.

Rome X Northern Spy is represented by only one individual and, this cross, therefore, throws little light on the inheritance of size and shape. This single representative, however, resembles the Rome in shape and even bears the distinct green and wide cavity which is so characteristic of this variety. In size it slightly outclasses either parent. This cross is not illustrated.

The nine offspring of Ralls X Northern Spy produced great variations in size and shape. This is to be expected since the difference in the size of the parents is more marked. The size of these seedlings ranges from fruits smaller than the maternal to larger than the paternal. Five of these seedlings resemble the Ralls in shape, one the Northern Spy and three are intermediates; all are shown in Plates LIII and LIV.

In the Ben Davis X Esopus progeny are two individuals resembling Ben Davis, one an intermediate and one Esopus-like in shape, all shown in Plate LV. The reciprocal cross gave seven of Esopus resemblance, eleven of intermediate, ten of Ben Davis and one of unclassifiable shape. This cross gives the widest range of variation in size and shape — a fact which may be accounted for by the greater number of individuals, but not by the difference in size of the parents. Seven of the seedlings produced fruit larger than Ben Davis and four of them bore fruit smaller than the Esopus — the smallest being no larger than the Lady apple. In shape a few individuals produced fruit more elongated that Ben Davis while others bore fruit as oblate as the Lady. Plates LVI, LVII, LVIII, and LIX show the size and shape of the Esopus X Ben Davis apples.

Ben Davis X McIntosh gave three intermediates and four each of Ben Davis and McIntosh shapes. It is interesting to note in

this cross that the distinctive calyx end of the Ben Davis fruit was markedly impressed on a majority of the offspring. The size of the fruit was not noticeably variable, as only two individuals out of the eleven dropped below the McIntosh in size, and one of these two possessed a remarkably small core and produced only a few seeds — perhaps a sufficient reason for its inferior size. The remaining individuals average as large as the Ben Davis and several surpassed the McIntosh in size. Apples from this cross are shown in Plates LX and LXI.

Ben Davis X Green Newtown produced thirteen individuals. The size of the fruit in one of these seedlings is very large, being one-half as large again as Ben Davis. In fact, half of these seedlings average as large as Ben Davis and none of them fall below the Green Newtown in size as can be seen in Plates LXII and LXIII. In shape, six resemble Green Newtown, three Ben Davis and four an intermediate condition.

Acidity.—Acidity and sweetness are relative terms and unnumbered gradations varying from one extreme to the other occur. The separation of subacid from acid apples is difficult, for under more favorable circumstances the acidity may decrease to a marked degree. In this experiment all the parents are subacid varieties, and from an examination of the following data, it will be noted that sweet apples appear in the greater part of the crosses. The numbers in most cases are too few to expect an exact 3:1 ratio, yet the indications strongly favor such an assumption. In the cases where sweet apples did not appear, one must assume that the nonappearance is due either to chance or that all subacid varieties do not carry sweetness as a recessive character. This question can be settled only by further tests. The facts are presented as they appear and conclusions are drawn as far as the limited observations permit.

Ben Davis X Jonathan, both parents being subacid, gave two sweets and nine subacids, while Esopus X Jonathan produced two subacids. In the first cross, one might interpret sweetness or absence of acidity as a recessive to acidity — both parents carrying sweetness. The expected ratio 3:1 is very closely approximated. The second of these crosses throws no light on this assumption for the individuals are too few in number.

Ben Davis X Mother gives eight sweets, eleven subacids and one sour. If the sours and subacid fruits can not be definitely separated, then we have a ratio of 3:2 instead of 3:1 — sweetness being the recessive. Mother, according to this interpretation, must carry sweet as well as Ben Davis.

The four seedlings produced from Sutton X Northern Spy, and the one from Rome X Northern Spy are all subacid. These numbers are too few to hazard an explanation.

Ben Davis X Esopus gave four individuals, all of which are subacid and its reciprocal cross gave a total of seven sweets, twenty-one subacids and one sour. Assuming that the sour individual would have lost its acidity if the season had been more prolonged, we would have practically a 3:1 ratio in this reciprocal cross. The proportions are, however, worthy of note, even though they may be incorrectly interpreted. If the interpretation is correct, Esopus as well as Ben Davis must carry sweetness as a recessive character.

Ben Davis X McIntosh gives two sweets to nine subacids, and Ben Davis X Green Newtown, the same classes but in the proportion of 3 to 10. Both of these crosses are explainable by the 3:1 ratio, and this interpretation must make sweet a recessive in both parents.

Ralls X Northern Spy gave nine subacids and no sweets. In this case, we have two subacids giving no sweets, and therefore, it is doubtful whether one or both varieties carry a recessive sweet. If this be the case, subacid varieties are not necessarily hybrids between sweets and acids. These results are at least valuable from the practical side for it shows that sweet apples can be secured from subacid apples.

Ripening period.— Date of ripening is another character that is undoubtedly inherited, as from all of these crosses of late-ripening apples, only late varieties have been produced — the range of variation not extending on the average much more than a month on either side of the average mean of the parents. It is to be regretted that we have no crosses with parents differing widely in the date of maturity. However, as no early varieties have been obtained from these crosses, it is safe to say that earliness is probably not a recessive character. Season, like size and

shape, may be either composed of many factors or it may be inherited as an intermediate condition — a question, of course, still open for experimental evidence.

INHERITANCE IN THE SEVERAL VARIETIES.

The results of the study of Mendelian inheritance in this experiment may be put in more workable shape for the apple-breeder if the discussion of the several characters are summarized under the varieties crossed. At the risk of considerable repetition, such a summary is now given.

Ben Davis.— In the six crosses in which this apple was used, the results indicate that yellow is not carried by Ben Davis — the heterozygous R y progeny being able to obtain their yellow from the other parent in each case. In transmitting shape, Ben Davis was less prepotent than either Jonathan or Green Newtown. In the other cases, the individuals showing preponderance of Ben Davis shape were about equal in number to those showing the shape of the other parent. The term prepotent is here used to mean that either the shape-forming characters of one variety are less heterozygous than those of another, or, that such characters of one parent are dominant over those of the other. The greater the number of heterozygous characters, the greater the number of segregations or splittings that will take place. In size of fruit, the Ben Davis crosses were intermediate as a rule, although the cross with the Green Newtown produced offspring larger than either parent and none smaller. Sweetness appeared as a recessive in all Ben Davis crosses except with Esopus and here the four individuals are too few to permit conclusions.

Esopus.— The crosses between Ben Davis and Esopus are the only ones with sufficient numbers to warrant a postulation as to the gametic constitution of the Esopus color factors. The total individuals obtained are 21 pure reds and 12 individuals heterozygous for red and yellow. As the Ben Davis probably does not carry yellow, the yellow in these heterozygotes must have come from Esopus. Assuming that Ben Davis carries R R and Esopus R y we should expect a ratio of 1 R R to 1 R y. The ratio obtained, 7:4, indicates that red is not carried in such

a simplex condition. The fruit shape in the progeny of these crosses is intermediate, while the size is very variable, indicating that one or more of the progenitors of the parents must have borne small fruits. Esopus carries sweetness as a recessive, there being 7 sweet, 25 subacid and 1 acid apple, a close approximation to a 3:1 ratio.

Green Newtown.— The inheritance of fruit characters in this variety are based on thirteen individuals obtained from crosses with Ben Davis. If Ben Davis carries only red and Green Newtown only yellow, all the progeny should have been heterozygous for these colors, but 8 R R and 5 R y apples were obtained. Perhaps the light blush on the Green Newtown signifies the presence of a red unit factor, but this point can be settled only by growing selfed seedlings. As previously noted, the Green Newtown shape is more prepotent than the Ben Davis — the obliqueness of the Newtown, in particular, appearing in the offspring. The fruits of the progeny did not fall below either parent. This fact indicates that the progenitors of the Green Newtown bore large fruits, for if small size is carried as a recessive in Ben Davis, a union of small gametes would probably have taken place even though the numbers are small. Sweetness appeared in a ratio of nearly 3:1, which signifies that this character is carried as a recessive.

Jonathan.— This variety carries only red in its gametes, as in the eleven progeny obtained from a cross with Ben Davis, no evidence of yellow was noted. Jonathan proved to be the more prepotent parent in the transmission of shape, for nine of the eleven seedlings resembled the former. Sweet apples appeared in the proportion of 2:9, which closely approximates a 1:3 ratio, based on sweetness as a recessive to acidness.

Lawver.— No hypotheses can be advanced as to the inheritance of this variety's characters, as only one seedling, obtained from a cross with McIntosh has been described. Its dark red color, however, suggests an absence of yellow.

McIntosh.— Three R y fruits appeared in the eleven Ben Davis X McIntosh seedlings, and one R y in the Lawver cross. If the Ben Davis and Lawver are pure reds then McIntosh must have supplied the yellow in both cases. The white

flesh of the McIntosh behaved as a recessive to the yellowish white color of the Ben Davis. In the inheritance of shape and size, McIntosh and Ben Davis were equally prepotent, for, as many progeny resembled one parent as the other and all were intermediate in size. The appearance of two sweets to nine sub-acid fruits supports the statement that the former character is borne as a recessive in the McIntosh.

Mother.— When crossed with Ben Davis, three heterozygous and seventeen pure reds were produced. If these three individuals are undeveloped reds then Mother does not carry yellow. If, however, Mother carries yellow, its red must be complex in structure. A few more seedlings resembled the Mother in shape than the Ben Davis, but not enough more to warrant the drawing of conclusions. Size was inherited in an intermediate condition and sweetness as a recessive though in the proportion of 2:3, instead of a simple 1:3.

Northern Spy.— This variety crossed with Sutton gave three reds and two yellows tinged with red; crossed with Ralls gave seven pure reds and two heterozygous reds; in the cross with Rome one heterozygous red was the result. The presence of nearly yellow individuals in the first cross signifies either that yellow is carried as a recessive or a simplex red is present in the Northern Spy. Shape in this variety was more prepotent than in Sutton but much less so than in Ralls which impressed its shape on five of the nine seedlings — three being intermediates. The Northern Spy crosses, as a rule, gave large fruits but in the Ralls cross small fruits appeared — the presence of which indicates that both varieties carry small size in their gametes. (See Ralls.) No sweet apples appeared in the Northern Spy crosses which fact indicates that sweetness is not a recessive in this variety. However, if Ralls, Rome and Sutton, with which it was crossed, do not carry sweetness, this character would not appear since it would have been dominated by the acid-producing factor.

Ralls.— If Northern Spy carries yellow, then this variety either does not or its red is complex in composition. This opinion is based on the appearance of seven pure reds and only two heterozygous reds. If both varieties carry yellow, the pro-

portion should be 1 R: 2 R y: 1 Y, that is, one pure yellow should have appeared to three pure and heterozygous reds. As already noted in the Northern Spy discussion, Ralls is more prepotent in the transmission of shape-determining factors. In the Northern Spy and Ralls progeny, we have individuals both larger and smaller than either parent — this variability may be explained by assuming that the progenitors of Ralls and Northern Spy covered variations of similar magnitude. The transmission of acidity in Ralls is discussed under Northern Spy.

Rome.— Little can be said as to the inheritance of the characters of Rome from the one individual grown. Its shape and stem cavity were transmitted to this seedling.

Sutton.— This variety gave three reds and two nearly yellows when crossed with Northern Spy. Thus Sutton as well as the Spy must carry either yellow or a simple red. In the transmission of shape, Northern Spy seems to be sightly prepotent, for it impressed its shape on three fruits to the Sutton's one. Little can be said of the transmission of size except that the Sutton did not give small fruits. The transmission of flavor in Sutton is discussed under Northern Spy.

Conclusion.— The inheritance of skin color, flesh color, size and shape are more or less hypothetical but acidity is undoubtedly inherited as a Mendelian character. Combining crosses, all of which were produced from subacid parents, we get a total of 22 sweet, 82 subacid and 2 acid apples. Fifteen of these are from crosses in which sweetness is not carried by one or both parents, and, therefore, must be eliminated, thus leaving 22 sweets to 69 subacids and acids, numbers which approach very closely the theoretical 1:3 ratio. If the sweet apples contain a higher amount of sugar than the subacid apples, and this assumption is favored, the results are analogous to those obtained by Pearl and Bartlett with crosses of corn[1] where high sucrose content behaved as a recessive to low sucrose.

CONCRETE RESULTS.

All will be interested, it is certain, in knowing how many of the progeny of these crosses seem to the writers to have suffi-

[1] Pearl, R. and Bartlett, J. M., 1911. *Ztschr. Induk. Abstamm. Vereb.* **6**: 27. 1911.

cient value to name or test further. The following are the number: From the eleven Ben Davis X Jonathan crosses, one is marked for propagation, four for further testing and six for discarding. Ben Davis X Mother gave two seedlings worthy of propagation and eighteen for discarding. Ben Davis X Esopus produced four worthless seedlings but the reciprocal cross has contributed two worthy of propagation, one for future testing, twenty-six for discarding. Ben Davis X McIntosh gave two desirable varieties, three for further testing and six for discarding. Ben Davis X Green Newtown gave four desirable varieties from thirteen seedlings. Esopus X Jonathan gave one for further testing, one for discarding, and McIntosh X Lawver has produced one individual which is still retained for further test. The Northern Spy crosses have done well, for Sutton X Northern Spy gave two worthy of propagation, three worthy of further testing and none for discarding. Ralls X Northern Spy produced one desirable variety, one worthy of further consideration and seven undesirables; and Rome X Northern Spy gave one of no special merit.

The data given, even though meager, seem to show that the Ben Davis and the Esopus crosses are of little use in breeding work, and that the McIntosh, Northern Spy and Green Newtown — all varieties of very high quality — might well be used extensively in all work where the object is to obtain varieties of high quality. Few, indeed, of these crosses fell below the average of cultivated varieties in size of fruit, handsome appearance of the apples and in tree characters that make a variety desirable. Fourteen apples worthy of propagation out of 102 crosses so far fruited, gives a most hopeful outlook to apple breeding. These have been more or less distributed to the fruit growers of New York. The following are descriptions of the new varieties:

Clinton. *Ben Davis X Green Newtown.*— Tree vigorous, upright-spreading, open-topped, productive; branches stocky, ash-gray; leaves medium in number, 3⅞ inches long, 1⅞ inches wide, dark green, pubescent, with sharply serrate margins; petiole 1⅝ inches long.

Season, December to February; 2¼ inches by 2 15-16 inches in size, roundish to oblate-conic, often oblique, irregular; cavity

acute, of medium depth and width often heavily russeted, compressed; basin of medium depth and width, abrupt, furrowed; calyx partly open, with acute lobes; color greenish-yellow, blushed with dull bronze, splashed with carmine, prevailing effect red; dots large, russet, conspicuous; stem 11-16 inch long, thick; skin tender, smooth, oily, glossy; core axile, large, partly open; core-lines clasping; calyx-tube short, wide, broadly conical; carpels broad-oval, emarginate; seed large, plump, acute, 7 in number; flesh yellowish, firm, crisp, tender, juicy, subacid, aromatic; of good quality.

This apple is very attractive in appearance and of very good quality, resembling Green Newtown in size, shape and quality but of a handsome red color.

Cortland. *Ben Davis X McIntosh.*— Tree of medium vigor, drooping, dense-topped, productive; branches slender; leaves numerous, 4 inches long, 2¼ inches wide, dark green, pubescent, with serrate margins; petiole 1 3-16 inches long.

Season, November to February; 2½ inches by 3⅛ inches in size, roundish-oblate, ribbed, uniform; cavity obtuse, broad, much-russeted, smooth; basin of medium width and depth, obtuse or somewhat abrupt, slightly furrowed; calyx partly open, small, with acuminate, separated lobes broad at the base and medium in length; color greenish-yellow overspread with bright red, darker on the sunny side, splashed and striped with carmine; dots few, small, light gray; stem variable in length, averaging ¾ inch long, slender; skin tough, smooth, waxen, dull, with much bloom; core partly open; core lines clasping; calyx-tube long, conical; carpels obovate, emarginate; seed of medium size, wide, plump, obtuse, numerous; flesh whitish, often with slight tinge of pink, fine-grained, crisp, tender, juicy, subacid, aromatic; of good quality.

In appearance Cortland closely resembles McIntosh in color, shape and flesh characters. It promises to be a valuable commercial apple of the McIntosh type.

Herkimer. *Ben Davis X Green Newtown.* Tree vigorous, upright, slightly spreading, medium productive; branches rather thick; leaves 4 inches long, 2⅜ inches wide, dark green, rather pubescent; with margins inclined to crenate; petiole 1⅝ inches long.

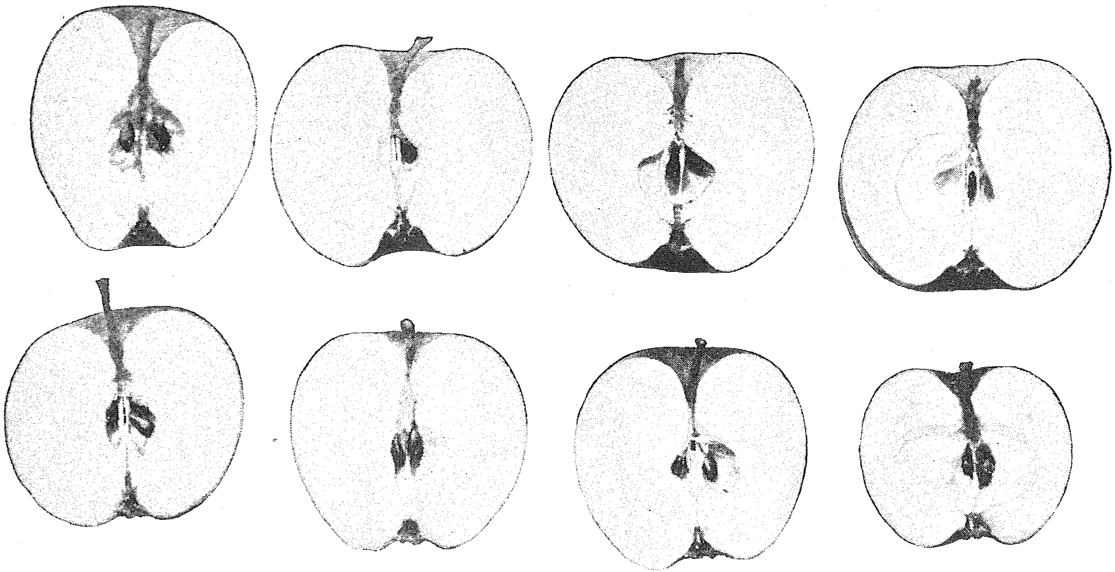


Plate XLVII.—Ben Davis × Mother: Parents and Progeny.
Ben Davis, first figure in upper row; Mother, first in lower row; Rockland, third in upper row.
(Reduced one-half.)

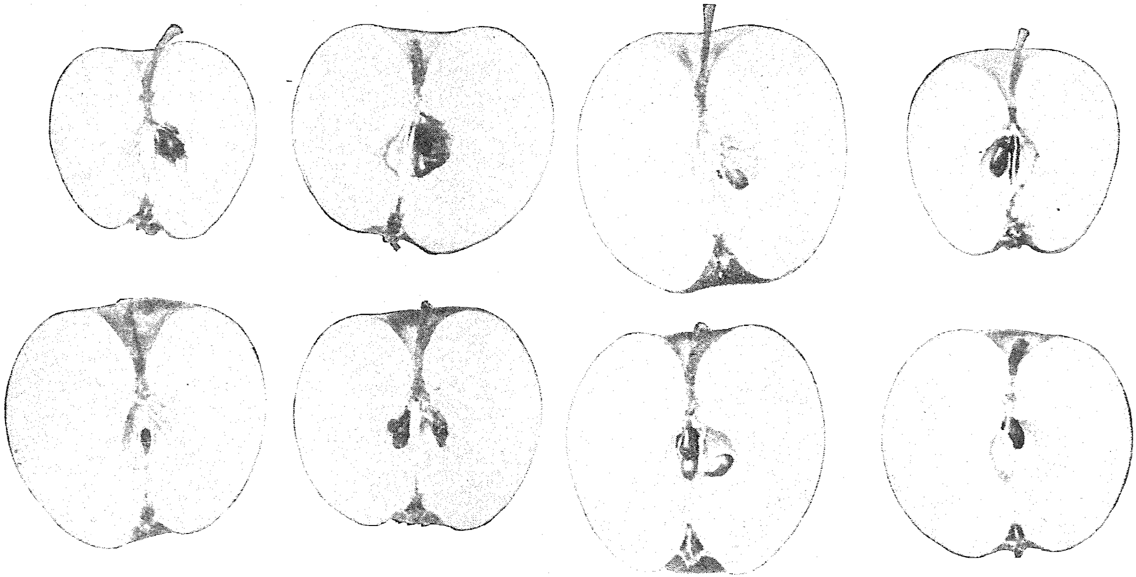


PLATE XLVIII.— BEN DAVIS × MOTHER: PROGENY.
(Reduced one-half.)

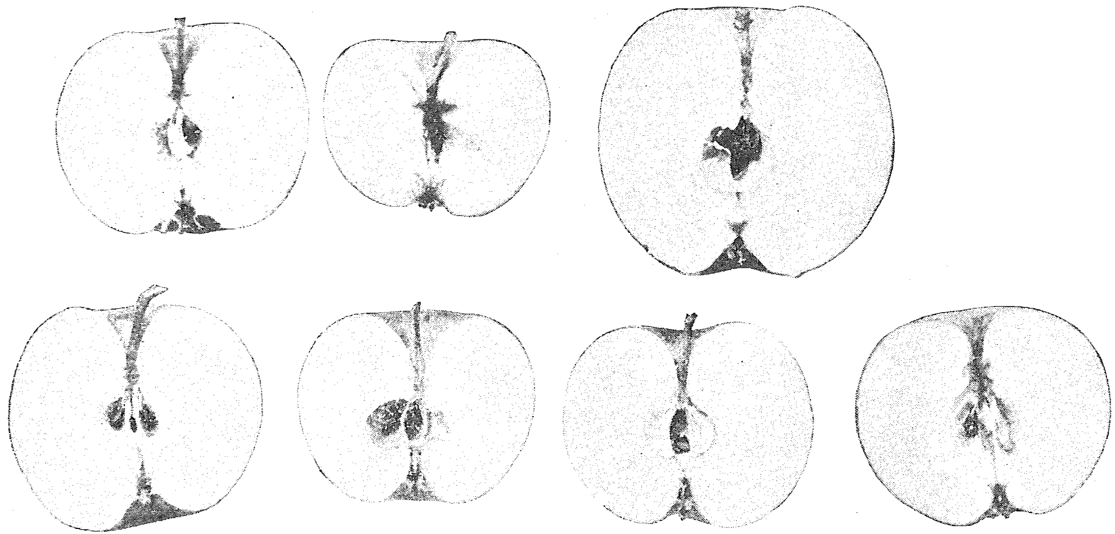


Plate XLIX.— Ben Davis × Mother: Progeny.
Schenectady, last figure in upper row.
(Reduced one-half.)

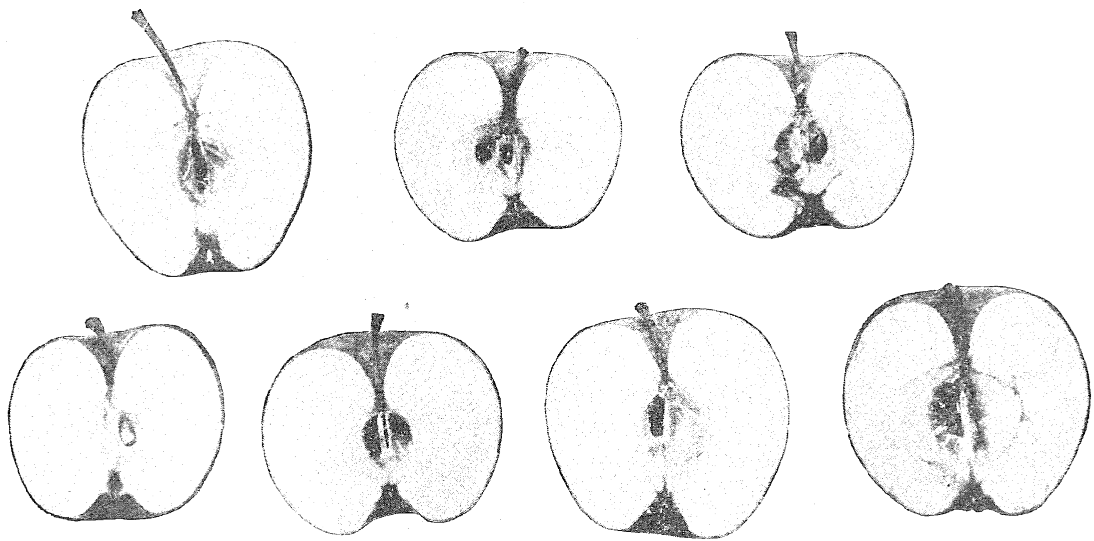


Plate L.— Ben Davis × Jonathan Cross: Parents and Progeny.

Ben Davis, first figure in upper row; Jonathan, first in lower row.

(Reduced one-half.)

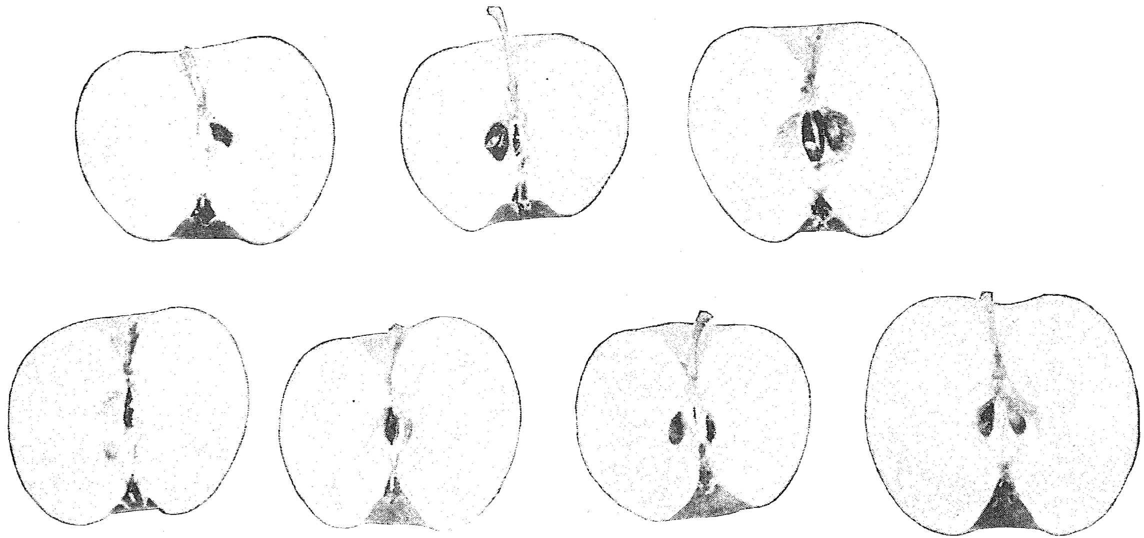


Plate LI.—Ben Davis × Jonathan Cross: Progeny.

Rensselaer, third figure in lower row.

(Reduced one-half.)

Plate LII.— Sutton × Northern Spy Cross: Parents and Progeny.

Sutton, first figure in upper row; Northern Spy, first in lower row; Tioga, fourth in lower row; Oswego, second in lower row.

(Reduced one-half.)

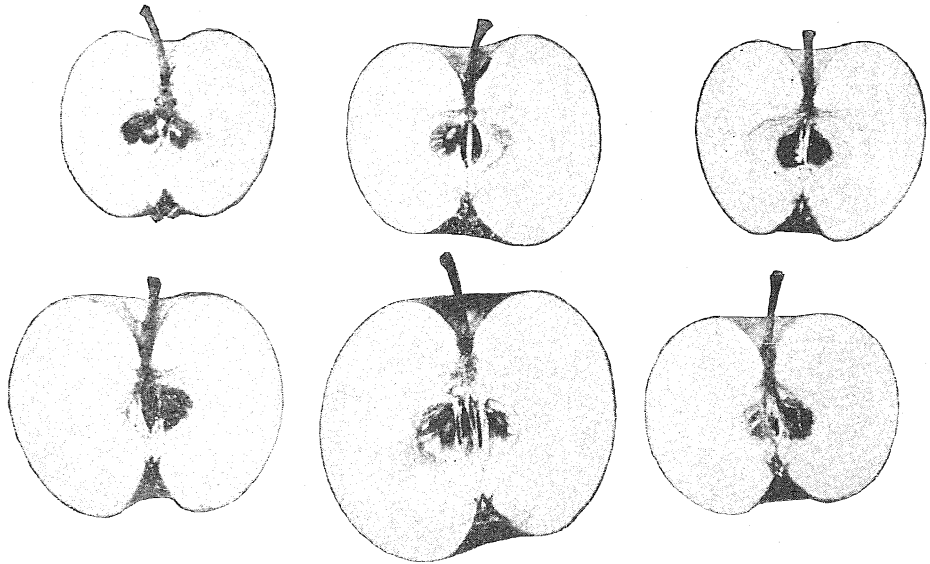


PLATE LIII.—RALLS × NORTHERN SPY CROSS: PARENTS AND PROGENY.

Ralls, first figure in upper row; Northern Spy, first in lower row; Schoharie, second in lower row.

(Reduced one-half.)

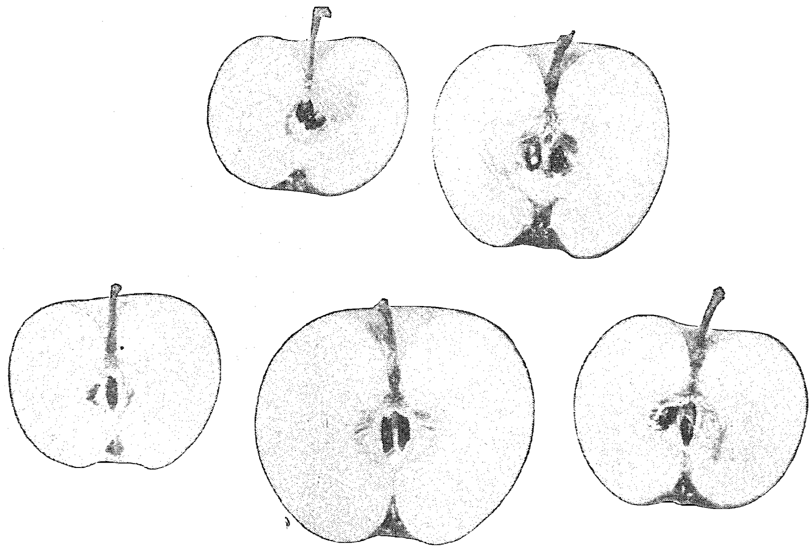


PLATE LIV.— RALLS × NORTHERN SPY CROSS: PROGENY.
(Reduced one-half.)

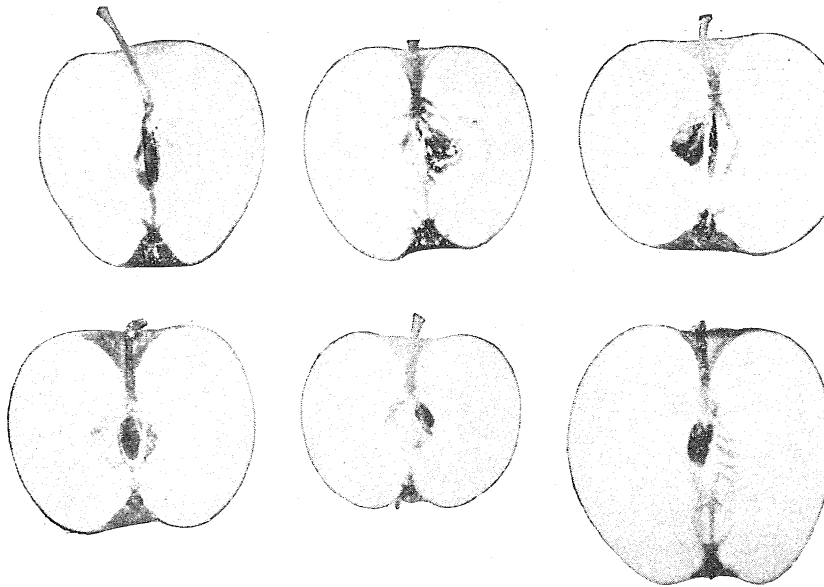


Plate LV.— Ben Davis × Esopus Cross: Parents and Progeny.
Ben Davis, first figure in upper row; Esopus, first in lower row.
(Reduced one-half.)

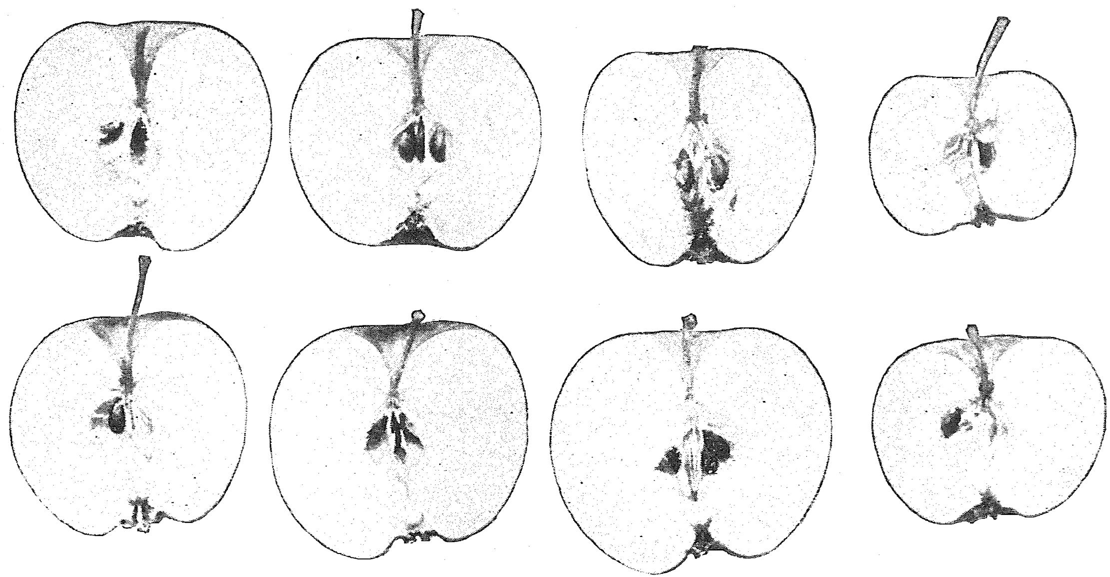


Plate LVI.— Esopus × Ben Davis Cross: Parents and Progeny.

Esopus, first figure in upper row; Ben Davis, first in lower row.

(Reduced one-half.)

Plate LVII.— Esopus × Ben Davis Cross: Progeny.
(Reduced one-half.)

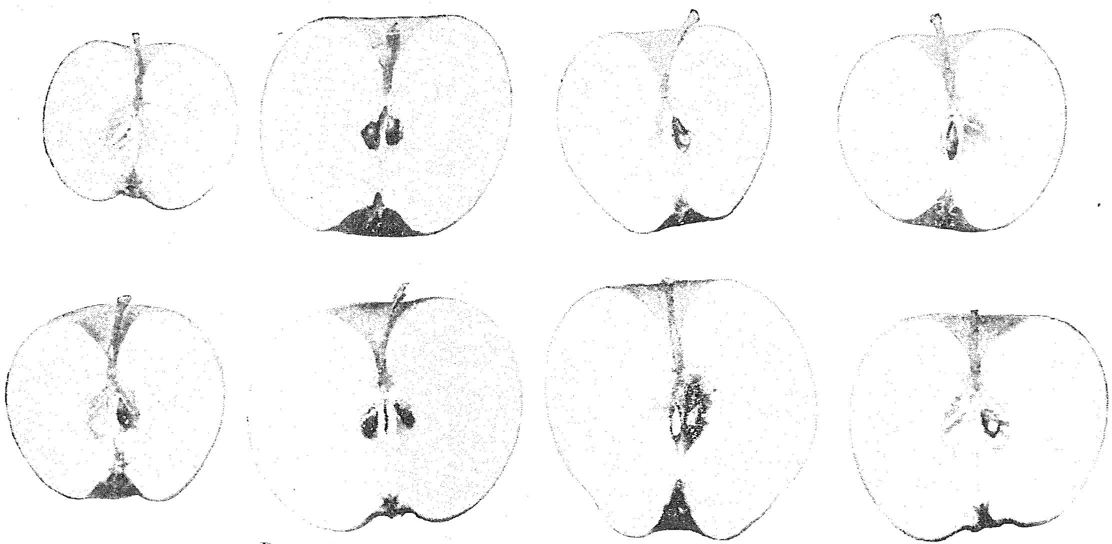


PLATE LVIII.—ESOPUS × BEN DAVIS CROSS: PROGENY.
(Reduced one-half.)

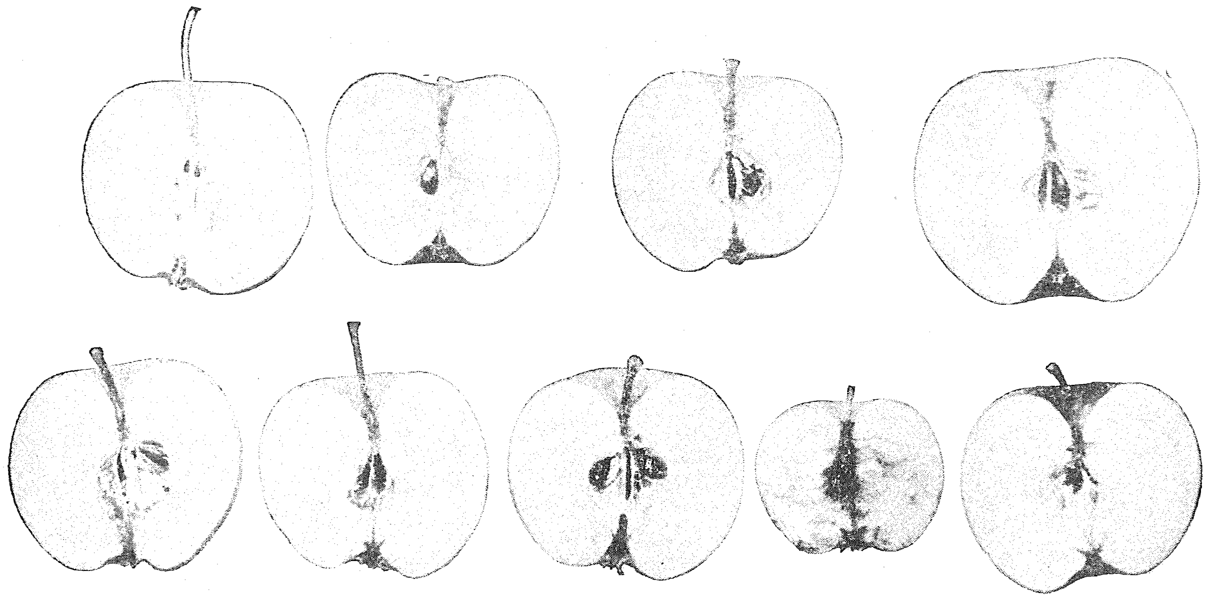


PLATE LIX.— ESOPUS × BEN DAVIS CROSS: PROGENY.

Nassau, third figure in lower row.

(Reduced one-half.)

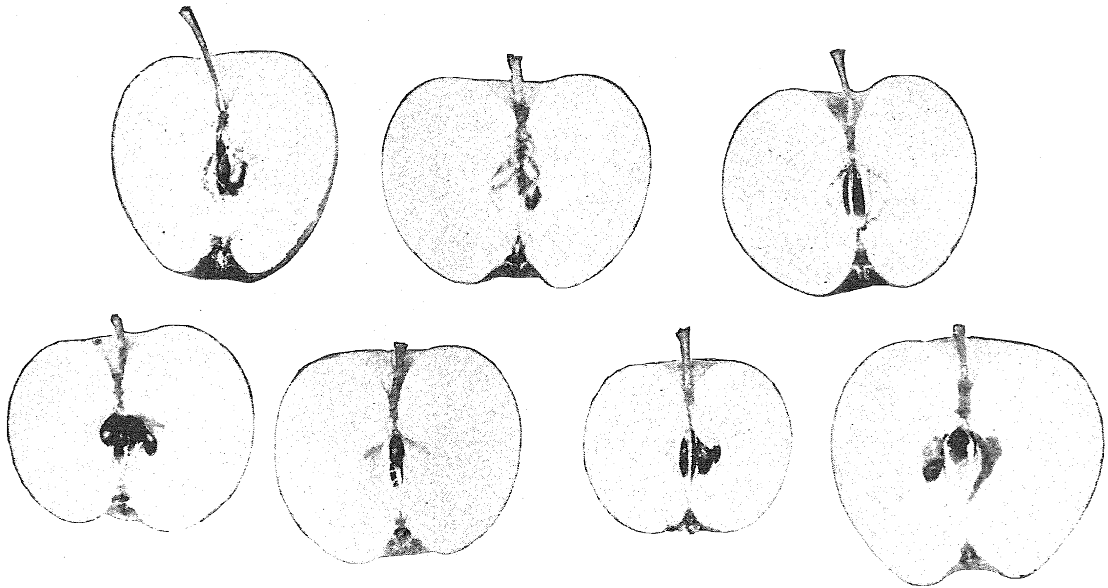


Plate LX. — Ben Davis × McIntosh Cross: Parents and Progeny.

Ben Davis, first figure in upper row; McIntosh, first in lower row.

(Reduced one-half.)

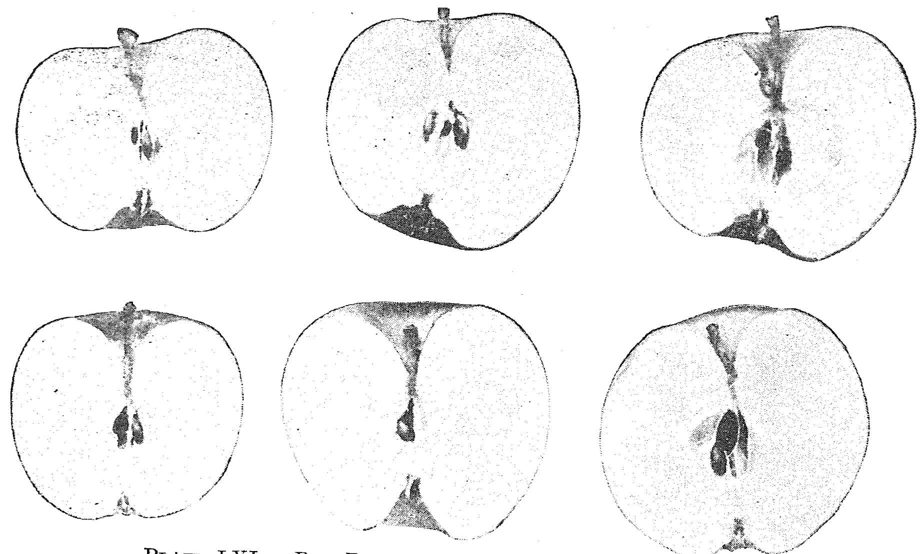


Plate LXI.— Ben Davis × McIntosh Cross: Progeny.
Cortland, first figure in upper row; Onondaga, second in upper row; Otsego, first in lower row.
(Reduced one-half.)

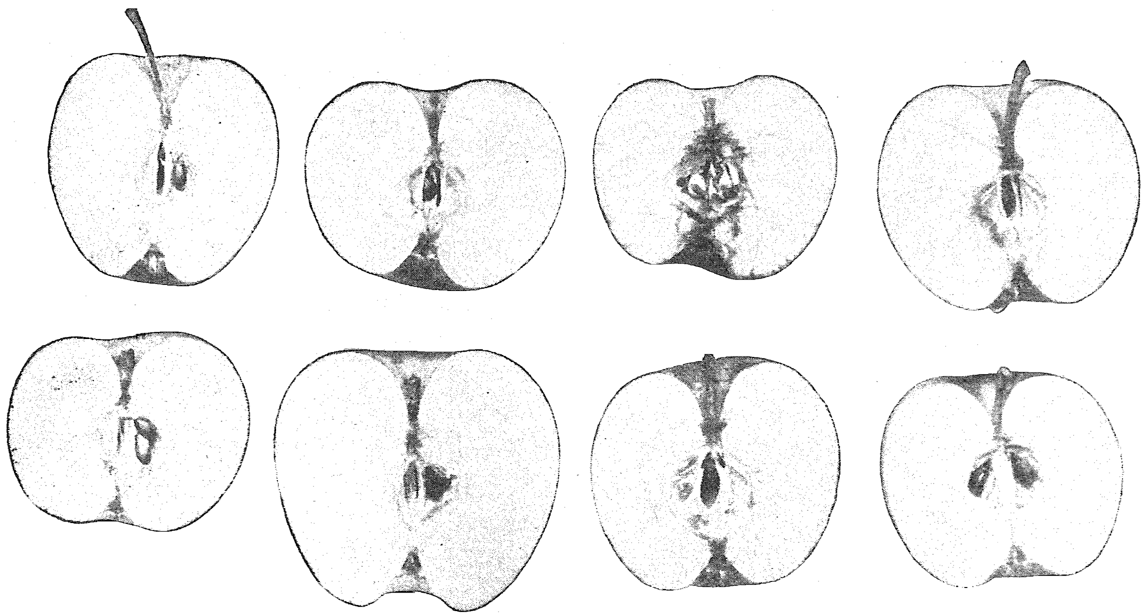


Plate LXII.— Ben Davis × Green Newtown Cross: Parents and Progeny.
Ben Davis, first figure in upper row; Green Newtown, first in lower row; Clinton, second in upper row.
(Reduced one-half.)

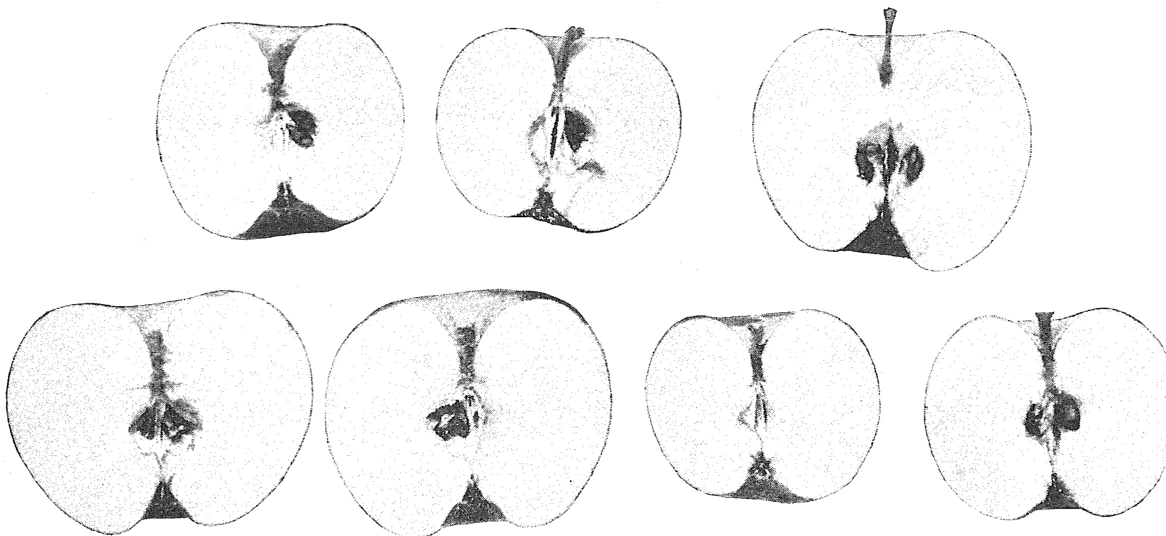


Plate LXIII.—Ben Davis × Green Newtown Cross: Progeny.

Westchester, third figure in upper row; Saratoga, second in lower row; Herkimer, fourth in lower row.

(Reduced one-half.)

Season, December to March; large, roundish to oblong-conic, irregular; cavity acuminate, deep, broad, marked with russet which often overspreads upon the base, slightly furrowed; basin deep, wide, abrupt, furrowed and corrugated; calyx slightly open, of medium size; color greenish-yellow, partly overspread with red, irregularly splashed and striped with dull carmine; dots large, russet; stem of medium length, thick; flesh yellow, firm, coarse, juicy, brisk subacid; of good quality.

Herkimer resembles Ben Davis both externally and internally more than the Green Newtown but is better in quality. Its good quality, handsome appearance and long-keeping properties, all commend it.

Nassau. *Esopus X Ben Davis.* Tree vigorous, upright spreading, productive; branches somewhat slender; leaves $3\frac{1}{2}$ inches long, $2\frac{1}{16}$ inches wide, dark green, heavily pubescent below, with crenate margins; petiole 1 inch long.

Fruit matures in late October or early November; season, December to March; medium in size, oblate; cavity wide, rather deep; basin wide, shallow, furrowed; color pale yellow, splashed, striped and mottled with bright pinkish-red, blushed on the sunny side; stem medium to long, thick; flesh firm, coarse, juicy, crisp, pleasant subacid, aromatic; good in quality.

Nassau is far better in quality than Ben Davis but is hardly equal to Esopus. The color is more like that of Ben Davis than of Esopus — the contrasting colors of red and yellow being most attractive.

Onondaga. *Ben Davis X McIntosh.*— Tree not very vigorous, upright, dense-topped, productive; branches slender; leaves numerous, $3\frac{3}{4}$ inches long, 2 1-16 inches wide, medium green, pubescent, with finely serrate margins; petiole $1\frac{7}{8}$ inches long.

Season, November to January; $2\frac{3}{8}$ inches by $2\frac{3}{4}$ inches in size, roundish-conic, irregular; cavity obtuse, shallow, greenish-russeted, smooth; basin shallow, obtuse, furrowed; calyx open, large, with long, narrow, acuminate, much separated lobes; color greenish-yellow, almost entirely overspread with dark McIntosh red, darker on the sunny side, splashed and mottled with dark carmine, prevailing effect dark red; dots few, small, grayish or pinkish, obscure; stem $\frac{3}{4}$ inch long, slender; skin tough, smooth.

waxen, dull, with considerable bloom; core abaxile, small, closed; core-lines clasping; calyx-tube short, conical; carpels oval, emarginate, slightly tufted; seed large, plump, acute, 8 in number; flesh tinged with yellow, firm, crisp, tender, juicy, sprightly subacid, aromatic; of good quality.

This apple is very attractive in color and in size and is at least desirable for cooking and would doubtless be relished by most persons as a dessert fruit. It is the general type of McIntosh externally except that it is slightly more conic.

Oswego. *Sutton X Northern Spy.*— Tree vigorous, upright-spreading, dense-topped, productive; branches stocky; leaves numerous, 3¾ inches long, 2 1-16 inches wide, dark green, slightly pubescent, with finely serrate margin; petiole 1 7-16 inches long.

Season, December to April, 2⅝ inches by 3 5-16 inches in size, roundish-conic, ribbed, sides unequal; cavity acute, deep, broad, russeted, often compressed; basin deep, abrupt, smooth; calyx open, large, with broad, acute, separated lobes; color greenish-yellow overspread with dull pinkish red, splashed and striped with darker red, prevailing effect dull red; dots numerous, large, grayish-russet; stem ¾ inch long, thick; skin tough, smooth, dull, covered with bloom; core abaxile, large, open; core lines clasping; calyx-tube long, wide, conical; carpels roundish, slightly emarginate; seed often abnormal being grown together, usually small, wide, short, plump, obtuse, 12 in number; flesh yellowish, firm, crisp, tender, juicy, brisk subacid; very good in quality.

Oswego resembles Northern Spy, though larger, more conical, and brighter in color. The flesh, in color and texture, resembles Spy but the flavor, while equal to that variety, is not that of the Spy.

Otsego. *Ben Davis X McIntosh.*— Tree vigorous, upright-spreading, open-topped, productive; branches stocky; leaves numerous, 3¾ inches long, 2¼ inches wide, medium green, pubescent, with slightly crenate margins; petiole 1⅝ inches long.

Season, November to February; 2⅛ inches by 2 5-16 inches in size, oblong-conic, oblique, not uniform; cavity acute, deep, russeted, compressed; basin shallow, narrow, obtuse, furrowed,

compressed; calyx closed, small, with short, narrow, acute lobes; color pale yellow overspread with mottled dark red, splashed and striped with carmine, prevailing effect red; dots numerous, small; stem 11-16 inch long, slender; skin tender, smooth, waxen, covered with bloom; core abaxile, open; core-lines clasping; calyx-tube short, wide, conical; carpels ovate, emarginate; seed of medium size, wide, plump, obtuse, 4 in number; flesh yellow, firm, crisp, tender, medium juicy, mild subacid; good in quality.

This apple is propagated because of its handsome color, good quality, small core and sparsity of seed. The fault that will condemn it if it fails, is small size.

Rensselaer. *Ben Davis X Jonathan.*—Tree vigorous, spreading, productive; branches stocky; leaves numerous, 1⅞ inches wide, 3½ inches long, pubescent, with crenate margins; petiole 1 5-16 inches long.

Season, December to February; 2⅝ inches by 2¾ inches in size, roundish-conic to truncate, uniform; cavity acuminate, deep, greenish-russeted, symmetrical, basin narrow, abrupt, furrowed; calyx small, partly opened, with obtuse lobes; color yellow with a dull red blush, splashed with carmine, prevailing effect red; dots numerous, large, yellowish; stem ⅞ inch long, slender; skin tough, smooth, oily, marked with grayish scarf-skin; core axile, of medium size, closed; core-lines clasping; calyx-tube long, wide, conical; carpels ovate, emarginate; seed of medium width, long, plump, acute, eight in number; flesh yellowish, firm, crisp, tender, juicy, subacid, aromatic; of good quality.

While of but medium size, Rensselaer is so attractive in color and of such high flavor as to make it a valuable dessert fruit. It is of the type of Jonathan both externally and internally.

Rockland. *Ben Davis X Mother.*— Tree of medium vigor, somewhat spreading and straggling, productive; branches rather slender; leaves $2\frac{13}{16}$ inches long, 2 inches wide, light green, somewhat pubescent, with serrate margins; petiole $1\frac{1}{16}$ inches long.

Season, November to January; of medium size, roundish-truncate, symmetrical; cavity acuminate, deep, russeted, symmetrical; basin deep, very wide, abrupt, furrowed; calyx partly open,

large; color yellow, entirely overspread with dark red, splashed, mottled and obscurely striped with carmine; dots few, small, pinkish-yellow; stem long, thick; skin tough, smooth, dull; core axile, closed; core-lines clasping; calyx-tube short, wide, conical; carpels obovate, emarginate; seed small, short, plump, obtuse, tufted; flesh yellowish, coarse, crisp, tender, juicy, sprightly subacid, aromatic; good to very good in quality.

The fruit of this cross is of the type of Mother. It is most pleasing in appearance, although small, resembling Mother in size, shape, color, texture, flavor and quality. This apple ought to be especially valuable as a dessert fruit.

Saratoga. *Ben Davis X Green Newtown.*— Tree vigorous, upright-spreading, dense-topped, productive; branches stocky; leaves 4 inches long, 2 3-16 inches wide, dark green, pubescent, with sharply serrated margins; petiole 2 inches long.

Season, January to April; 2 9-16 inches by 3⅛ inches in size, roundish-conic to oblate, ribbed, uniform; cavity obtuse, deep, broad, russeted, furrowed; basin deep, wide, abrupt, furrowed; calyx open, large, with short, broad, acute, separated lobes; color greenish-yellow, overspread with bright purplish-red, splashed and mottled with crimson; dots numerous, yellowish; stem ⅝ inch long, thick; skin tender, smooth, very oily; core abaxile, large, open; core-lines clasping; calyx-tube short, wide, conical; carpels ovate, emarginate, tufted; seed wide, plump, acute, tufted, 10 in number; flesh greenish-yellow, firm, coarse, crisp, tender, juicy, subacid, sprightly; of good quality.

This apple is particularly valuable because of its bright color and large size. Its quality is much superior to Ben Davis being nearly or quite as good as Green Newtown. Its season is late.

Schenectady. *Ben Davis X Mother.*— Tree vigorous, upright, dense-topped, productive; branches medium to thick; leaves numerous, 4¼ inches long, 2½ inches wide, dark green, pubescent, with distinctly serrate margins; petiole 1 3-16 inches long.

Season, November to January; 2 15-16 inches by 3¼ inches in size, roundish-conic, sides unequal, ribbed; cavity obtuse, shallow, narrow, russeted, compressed, sometimes lipped; basin narrow, obtuse, furrowed; calyx open, with broad, acute lobes; color greenish-yellow overspread with bright red, mottled and

splashed with carmine, prevailing effect red; dots numerous, small, grayish; stem 7/8 inch long, slender; skin tender, smooth, waxen; core abaxile, large, open; core-lines clasping; calyx-tube long, wide, conical; carpels obovate, emarginate; seed wide, plump, acute, 8 in number; flesh yellowish, firm, coarse, crisp, tender, juicy, subacid; of good quality.

This new variety is remarkably attractive, its size, shape and color, all being most pleasing. It is not quite high enough in quality to be called a first-class dessert fruit, but it is much better than Ben Davis and is a splendid apple.

Schoharie. *Ralls X Northern Spy.*— Tree vigorous, upright-spreading, productive; branches stocky; leaves numerous, 4 inches long, 2 1-16 inches wide, dark green, slightly pubescent, with distinctly serrate margins; petiole 1 7/8 inches long.

Season, November to March; 2 3/4 inches by 3 inches in size, roundish-conic, ribbed, irregular; cavity obtuse, shallow, narrow, greenish-russeted, compressed, furrowed; basin narrow, obtuse, furrowed; calyx open, small, with short, broad, acute lobes which are not separated; color greenish-yellow overspread with a mottled and striped dull red, prevailing effect, dull, striped red; dots numerous, small, grayish-russet, obscure; stem 1 3-16 inches long, slender; skin tender, smooth, waxen, core abaxile, large, very open; core-lines clasping; calyx-tube short, wide, broadly conical; carpels broad-ovate, emarginate; seeds small, plump, acute, 15 in number; flesh yellowish, firm, fine-grained, crisp, tender, juicy, pleasant but mild subacid, aromatic; of good quality.

Schoharie is of proper size but somewhat dull in color. Its flavor is such as to make it desirable either as a cooking or as a dessert apple. It is the type of Northern Spy in shape and color; the flesh, too, is that of the Northern Spy, more yellow, but having the same delicious flavor and aroma.

Tioga. *Sutton X Northern Spy.*—Tree very vigorous, upright-spreading, dense, medium productive; branches thick; leaves 3 1/4 inches long, 1 7/8 inches wide, dark green, with considerable pubescence beneath, with serrate margins; petiole 1 1/4 inches long.

Season, December to March; large, oblate-conic, ribbed, symmetrical; cavity acute, of medium depth and width, greenish-

russeted, furrowed, often lipped; basin shallow, narrow, obtuse, furrowed, sometimes compressed; calyx closed, with narrow, acute lobes of average length; stem short, thick; skin thin, tender, smooth, covered with heavy bloom; color pale yellow, blushed, mottled and faintly splashed with pinkish-red, prevailing effect yellowish; dots small, numerous, russet, often submerged; core abaxile, large, closed; core-lines clasping; calyx-tube short, wide, conical; carpels ovate, emarginate; seed small, wide, short, plump, obtuse, slightly tufted; flesh yellowish, firm, coarse, crisp, juicy, brisk subacid; of good quality.

A most promising variety because of its handsome appearance and high quality. The fruit is the type of Northern Spy in shape but is unlike either parent in color.

Westchester. *Ben Davis X Green Newtown.*— Tree vigorous, upright-spreading, open-topped, productive; branches stocky; leaves numerous, 3 13-16 inches long, 2 inches wide, dark green, pubescent, with sharply and coarsely serrate margins; petiole 1 7-16 inches long.

Season, November to January; 2⅝ inches by 3 inches in size, roundish-conic, ribbed, oblique; cavity acuminate, deep, broad, russeted, compressed; basin very deep, wide, abrupt, furrowed and corrugated; calyx wide, open, large, with long, narrow, acuminate, separated lobes; color yellow, overspread with dull red, mottled and splashed with darker red; dots numerous, large, grayish, obscure; stem 13-16 inch long, thick; skin tough, smooth, waxen and oily, covered with bloom; core axile, small, closed; core-lines clasping; calyx-tube long, wide, conical; carpels ovate, emarginate; seed wide, acute, 7 in number; flesh yellow, coarse, very tender, juicy, mild subacid, aromatic; good to very good.

Westchester resembles Green Newtown in shape, but has the color of Ben Davis while the quality is even better than that of its justly esteemed paternal parent.

APPLICATION OF RESULTS.

We have laid so much stress upon the Mendelian behavior of several characters of the apples crossed and so much is now heard of Mendel and his work, that the impression may be given that breeding apples consists almost wholly in making Mendelian

combinations of characters. Producing new combinations of characters by crossing is but a small part of the work of securing superior varieties of apples. The task of selecting different combinations of unit characters in the progenies of crosses is a tremendous one, requiring knowledge of the many varieties of apples, of all characters of apples and of what ones combined will make a variety superior to existing sorts. It is likely that the greatest part of the work in breeding apples is, or will be when the foundation for breeding is more firmly laid, this selection among the manifold combination of characters that can be made. Following in Mendel's footsteps, we have a quicker route to the desired results in breeding apples, but breeding will still be laborious, slow and disappointing, differing chiefly from that of the past in being now a problem and not of as old, a riddle.

How can Mendelian principles be made most serviceable to breeders of apples? The aim in breeding is to produce varieties with the greatest number of desirable characters and the least number of undesirable ones. Mendel has shown that characters are transmitted as units which segregate in accordance with a definite formula. It remains, then, for the breeder to take certain characters from one parent, others from another, and make as many combinations as possible from which the best can be selected. The first task is to determine how characters are inherited, after which they can be associated or disassociated somewhat as the breeder wishes. The behavior of the crosses in this experiment gives some indications of how certain characters are transmitted when found in the varieties involved and forms a basis, therefore, for breeding work with these varieties, and suggests, at least, how the characters discussed will behave in other varieties that may be crossed.

The application of Mendelian principles to breeding apples, as with other plants, will not be free from puzzling problems. Some of these may be briefly stated.

The determination of the factors by which the various characters are transmitted will prove a very difficult task. If all were simple characters depending upon a single factor, the work would be greatly simplified, but it is likely that we shall find that some of the most important characters of apples depend upon the

simultaneous presence of several distinct factors. Thus, in the crosses under study, there are indications that shape, size, and color of fruit, may depend upon the presence or absence of several factors.

Another difficulty is that characters, if recessive, may not appear in the F_1 generation. Now this skipping a generation, when it occurs, will greatly delay and complicate the breeding of plants that are propagated vegetatively, for, if the desired characters do not appear in the F_1 generation propagation cannot proceed at once.

The phenomena of coupling and repulsion, which has been worked out with several plants, though not yet understood, if it appears in apples will tend to complicate breeding processes. That is, some factors seem to be linked together and are so transmitted while others repel one another and refuse to be transmitted together.

Again, the bringing together of complementary factors which somehow in the past breeding of the fruit had become separated, may result in reversions and thus produce unexpected characters.

A breeder may want wholly new characters in apples. These he cannot obtain by making Mendelian combinations.

Existing characters, if we possibly except size and vigor, cannot be augmented by crossing.

To have all of the many characters represented in the offspring it is necessary to work with large numbers of plants — difficult to obtain and time-taking with apples.

It is probable that disappointments will most often come from the attempt to perpetuate variations which are fluctuations dependent upon environment and not upon the constitution of the gametes.

There is likely to be some confusion, for a time at least, until we have more knowledge on the subject, between what are known as "simple Mendelian characters" and "blending characters," or those which may be complex in composition, in which the offspring are seemingly intermediate between the parents.

GRAPE STOCKS FOR AMERICAN GRAPES.*

U. P. HEDRICK.

SUMMARY.

Different species of grapes show wide variations in adaptability to natural and cultural conditions. Cannot grape-growers take advantage of these variations and graft varieties that fail under some conditions on roots of those that thrive under the same conditions?

The possibility of improving the viticulture of New York by such grafting was the inspiration of an experiment at this Station to test various root stocks for the best varieties of American grapes.

In this experiment three groups of varieties have been grafted on St. George, Riparia Gloire and Clevener stocks and a fourth group on their own roots. The varieties grafted on these stocks were: Agawam, Barry, Brighton, Brilliant, Campbell Early, Catawba, Concord, Delaware, Goff, Herbert, Iona, Jefferson, Lindley, Mills, Niagara, Regal, Vergennes, Winchell and Worden.

The experiment was tried on the farm of I. A. Wilcox, of Portland, Chautauqua County, New York, in the Chautauqua Grape Belt. The vines were grown in two plats on two kinds of soil — Dunkirk gravel and Dunkirk clay. The planting plan and all of the vineyard operations were those common in commercial vineyards.

The original plan was to graft only on growing stocks but the loss of a large proportion of the grafted plants the first few years made it necessary to resort to bench-grafting on rooted plants as well. Later experiences show that bench-grafting on cuttings is probably the best method of starting a grafted vineyard.

Yearly accounts of the vineyard show that the vines passed through many vicissitudes. The experiment was started in 1902 when St. George and Riparia Gloire stocks from California were set and grafted in the field. Many of these died the first year.

*A reprint of Bulletin No. 355, December, 1912; for "Popular Edition," see p. 860.

The winter of 1903-04 was unusually severe and many more vines were either killed or so severely injured that they died during the next two years. The vines on St. George, a very deep-rooting grape, withstood the cold best. Fidia, the grape root-worm, was found in the vineyards early in the life of the vines and did much damage in some years. In the years of 1907 and 1909 the crops were ruined by hail.

But despite these serious setbacks it was evident throughout the experiment that the grafted grapes were better vines. And so, though the experiment is a partial failure through accidents, the results are thought to be worth publishing.

Tables II and III show that the grafted grapes are more productive than those on their own roots. As an example of the differences in yield, a summary of the data for 1911 from Table III may be given. In this year, an average of all the varieties on own roots yielded at the rate of 4.39 tons per acre; on St. George, 5.36 tons; on Gloire, 5.32 tons; on Clevener, 5.62 tons. The crops on the grafted vines were increased through the setting of more bunches and the development of larger bunches and berries.

The grapes on the grafted vines ripen a few days earlier than those on their own roots. This holds, in particular, as regards Gloire and Clevener, while with St. George a few varieties were retarded in ripening. Time of maturity is very important in this region, where there is danger of early frost to late ripening sorts and where it is often desirable to retard the harvest time of early grapes.

In the behavior of the vines the results correspond closely with those given for yields. In the relative growth ratings of varieties on different stocks the varieties on their own roots were rated in vigor at 40; on St. George, at 63.2; on Gloire, at 65.2; on Clevener, at 67.9. There is no way of deciding how much the thrift of the vines depends on adaptability to soil and how much on other factors. Since all of the varieties were more productive and vigorous on grafted vines than on their own roots, it may be said that a high degree of congeniality exists between the stocks and varieties under test.

The experiment suggests that it would be profitable to grow some of the fancy grapes of the region on grafted vines and that

it is well within the bounds of possibility that main-crop grapes can be profitably grafted.

It is recommended that grape-growers try small vineyards of grafted grapes, using as stocks the three tried in this experiment.

For procedure in growing a grafted vineyard the experiences given in this Bulletin should be taken in account, supplemented by a study of methods in California where grafted vineyards are commonly grown. Some of the practices in California are discussed on pages 517-519 but a more extended study of them should be made before engaging largely in growing grafted grapes.

This Station is repeating this experiment; it is hoped under more favorable circumstances.

INTRODUCTION.

The several species from which come cultivated grapes show wide variations in adaptability to natural and cultural conditions. Thus, cultivated Labruscas prefer loose, warm, sandy or gravelly soils; in the vineyard, Riparia varieties like a somewhat richer and heavier soil; the offspring of *Vitis æstivalis* thrive on lighter and shallower soils than even the Labruscas; *Vitis rupestris,* under cultivation, is better adapted than any other species to hard, dry soils. The species named respond quite differently to heat, cold, shade or sunshine and to moisture; they have varying capacities to withstand insects and fungi; and the productivity, the longevity and the size of the vine depend largely upon the species. The manifold types of grapes, too, behave quite differently under such cultural operations as propagation, cultivation and spraying.

The query, then, at once arises, "Cannot grape-growers take advantage of the variations in grapes and graft varieties that fail in some soils or climates, or because of certain insects or fungi, or that are not easily propagated or are short-lived, on roots of species that withstand these adverse conditions?" The signal success achieved in grafting varieties of *Vitis vinifera,* especially susceptible to attacks of phylloxera, on roots of species resistant to this insect, suggests that these other troubles may be more or

less overcome by grafting on roots of species free from these weaknesses. It was considered possible to improve the viticulture of New York by such grafting; and this possibility was the inspiration of an experiment at this Station to test various root stocks for the best varieties of American grapes. This bulletin is a report on the experiment — an experiment, however, it must be quickly said, which does not cover the broad field indicated in the opening paragraph, but a very limited one now to be outlined.

THE PROBLEM STATED.

The grapes in the work in hand are American grapes and more especially the hybrids between cultivated natives and varieties of *Vitis vinifera*. The attempt has been made to grow these grapes on stocks that were thought to be more vigorous, hardier to cold, better adapted to certain soils, more resistant to phylloxera and the fidia, that were easily propagated and that quickly made good unions in grafting. Will grafting on these selected root stocks or on any others prove profitable in commercial vineyards? The outstanding features of this experiment, most of which are but touched upon in this report, were, it was believed, fraught with far-reaching consequences to grape-growers — not merely a technical problem.

STARTING THE EXPERIMENT.

MATERIALS.

Stocks.— Through many experiments, followed by trials everywhere in vineyards, the French and the Californians developed stocks for nearly all conditions of grape-growing. The choice with these experienced vineyardists depends upon the variety to be worked on the stock, adaptation to soils, the purpose for which the grapes are to be grown and the adverse condition to be overcome by grafting. From the many stocks in use at home and abroad for Vinifera varieties, two were chosen for New York, St. George and Riparia Gloire. Since there are a few vineyards in this State grafted on the Clevener, a vigorous, healthy, direct producer of the

region, this grape was included as a stock in the test. In the experiment there are, then, three groups of grafted varieties to be compared with a fourth in which the vines are on their own roots. The botanical and horticultural characteristics of the stocks or fruits are not important at this time; but the merits and defects of the varieties as stocks, especially as to adaptations to soils, must be indicated. Since the first two stocks are hardly known on the Atlantic seaboard, what is said of them is based largely on their behavior in California and France.

St. George.— This grape, known nearly as well by its synonym, Rupestris du Lot, is a variety of *Vitis rupestris,* an inhabitant of Texas and the Southwest though ranging sparingly north and east and west of the State named to considerable distances. The species and this variety of it in particular, are pre-eminently well adapted to sandy, gravelly, rocky soils. St. George has remarkably strong roots which force themselves deeply into even very compact soils if the water table be not too near the surface. Its habit of deep rooting enables it to withstand drouths and seemingly, from this experiment, the roots withstand cold. The variety is very vigorous and communicates its strength to its grafts. It roots readily in the nursery and makes a very good union in grafting with either Vinifera varieties or other American species. It is by no means the most resistant stock to phylloxera but this need concern eastern growers but little. The chief defect of this stock as it grows in New York is that it suckers too freely.

Riparia Gloire de Montpellier.— This stock, known for short as Riparia Gloire, is, as its name suggests, a division of the well known *Vitis riparia,* the most widely distributed species of American grapes, ranging, in one region or another, eastward from the Rocky mountains to the Atlantic in the United States. The roots of this species and of its variety under consideration, quite unlike those of St. George, are small, hard, numerous, branch freely, and feed close to the surface of the ground. This stock grows best in deep rich soils which must not approach either extreme of wetness or dryness. Riparia Gloire is exceedingly

vigorous, even for the strong-growing species to which it belongs, and imparts its vigor to vines worked on it. Where hardiness is a factor in grape-growing, this stock should prove of value. As with all Riparias this variety grows readily from cuttings and makes a good stock for grafting, uniting freely and usually permanently with other species. Riparia Gloire, as are all of its species, is very resistant to phylloxera. The principal defect of this stock in California and Europe is that it is very particular as to soils. In our own experiment, there is a tendency for the cion to overgrow the stock.

Clevener.— This variety is a well known wine-grape in New York. It is a hybrid between *Vitis labrusca* and *Vitis riparia* with some characters suggesting that one of its parents might have blood of *Vitis æstivalis.* The vine is a rampant grower, hardy, succeeds in various soils and is probably adapted to a greater range of soils in this region than either of the other stocks discussed. It unites readily with other grapes and bears its grafts well. Although not tested thoroughly as regards phylloxera, it is probably as resistant as Riparia Gloire. In the past this has been considered the standard stock upon which to graft in this State.

Varieties used as grafts.— The varieties used as grafts in the experiment are, with one or two exceptions, the grapes most grown in commercial and home vineyards in New York. The selection of these varieties out of hundreds from which to choose, was dictated by varied considerations, chief of which were defects in adaptability to soil, climate and other environmental conditions which it was thought top-working might overcome. The grapes are so well known that there is no need of varietal description of any of them but all will be interested in knowing what considerations led to the selection of each variety.

Agawam.—Agawam is the most widely grown of Rogers' hybrids in the United States. It does pre-eminently well, however, only on heavy or clay soils and in many localities does not yield satisfactorily. In severe winters it is precariously hardy in New York.

Barry.— This is one of our best-flavored and longest-keeping hybrid grapes, resembling in color, flavor and keeping quality its European parent, Black Hamburg. Unfortunately it is not productive and it was hoped that it might be made to yield more by grafting on another stock.

Brighton.— Brighton is one of the few Labrusca-Vinifera hybrids which have attained prominence in commercial vineyards. The variety, however, has two most serious defects. It is self-sterile and it rapidly deteriorates in quality after picking. There was the possibility that working on another stock might influence the latter quality somewhat.

Brilliant.— Brilliant is a handsome, well-flavored, red grape, a cross between Lindley and Delaware, with such excellent keeping and shipping qualities that it might be grown with great profit in New York were it not for three faults — the bunches are variable in size and ripen unevenly, and in some soils the vines lack in productiveness. It was hoped that grafting on another stock might at least mitigate these faults somewhat.

Campbell Early.—At its best Campbell Early is unsurpassed in bunch, berry and vine by any American grape. But in most localities the variety falls far short of the perfection just indicated because it is adapted to but few soils and must have particular climatic and moisture conditions. Grafting on some other stock may lessen or do away with these weaknesses.

Catawba.— Catawba thrives in a great variety of soils and under various moisture and climatic conditions. It is the standard red grape of the markets of eastern America, more largely grown than any other red sort, but its cultivation could be still further extended in New York were it not for the fact that it ripens a week too late to be certain except in favored localities. In Europe and California, some varieties ripen a week or more earlier if grown on other than their own roots — hence, the trial of Catawba in this experiment.

Concord.—The Concord, known by all, is the dominant type of our native grapes, taking first place in American viticulture because of the elasticity of its constitution whereby it adapts itself

to varying conditions. Its use in this experiment is for purposes of comparison as to its behavior on different stocks rather than with the hope of correcting defects of adaptability.

Delaware.— Delaware is the standard in quality of all American grapes found on the markets. The variety, however, makes a very slow growth and is very capricious in certain soils. It would be a boon, indeed, if grape-growers could overcome these faults by grafting.

Goff.— Goff, a variety originating at this Station, is hardly surpassed in fruit characters but falls far short in bunch and vine characters. It was hoped that these might be improved by grafting.

Herbert.— Herbert, another of Rogers' hybrids, very similar to Barry in characteristics, is as near perfection in fruit characters as we have yet attained in the evolution of American grapes but is very capricious as to soils. It was especially hoped that this splendid grape would do better grafted than on its own roots.

Iona.— Iona is unsurpassed among American grapes for delicacy and sprightliness of flavor, keeping quality, and in making wines and champagne. But to be grown at all well it must have a soil exactly suited to its needs. It requires a deep, dry, sandy or gravelly clay and will not thrive on black loams or on poor sands or gravels — hence, the attempt to graft it on a stock more adaptable to soils.

Jefferson.— Jefferson is a cross between Concord and Iona, the good qualities of both parents showing. Unfortunately, it is a little too late and a little too tender to cold for a commercial variety, faults which it was hoped might be remedied by growing it on other roots than its own.

Lindley.—All concede that Lindley is the best one of the red grapes among the hybrids grown by Rogers. Yet it is little known commercially because of precariousness in bearing and lack of adaptation to some soils. Top-working might help overcome these defects.

Mills.— Of all our cultivated grapes, Mills probably varies most under different cultural conditions and because of this is

placed by some among the best sorts and by others is said to be worthless. There was the possibility that it might be top-worked on some stock which would cause it to bear more uniformly and larger crops of better fruit.

Niagara.— Niagara is the leading green grape east of the Rocky mountains, but it would be greatly improved for commercial vineyards if grafting on another stock should make it a little hardier and more productive.

Regal.— This variety is worthy extensive trial in the vineyards of New York, not, at the time this experiment was started, at least, having been well tested. It was thought deserving a trial and on other roots than its own.

Vergennes.— Vergennes is exceedingly variable in size of bunches and berries and in time of ripening. The vine, too, has a sprawling habit of growth. It is known that the last named fault can be corrected by grafting and there was the possibility that the other two could be, in which case this variety, because of the attractive appearance, high flavor, long-keeping quality of the fruit and the regularity with which it bears, would be a very profitable grape to grow.

Winchell.— The vines of Winchell are nearly perfect in hardiness, productiveness, and adaptability to soils; and the fruit characters are, in the main, good. The bunches, however, are small, loose and straggling, characteristics which might change if the vines were on other stocks.

Worden.—Worden possesses most of the good and bad qualities of Concord, differing chiefly in being a little earlier and having larger, sweeter and juicier berries. It is, however, a little more fastidious as to soils, a character which might change were the variety grafted on the stocks under trial.

SITE OF THE EXPERIMENT.

Location.— The experimental vineyard is located on the farm of I. A. Wilcox, about one mile south of Portland, Chautauqua County, New York. Portland is near the middle of the Chautau-

qua Grape Belt, a strip of land from two to six miles wide extending along the shore of Lake Erie for about 35 miles. This belt is recognized as the most important grape area east of the Pacific Coast. Though narrow, the strip is so variable in topography, climate and soil that the environment of the experiment should be noted carefully, for there is a marked difference in yield and quality of grapes in vineyards which seemingly differ but little in the natural factors named.

Topography.— The Chautauqua Grape Belt is divided lengthwise, parallel to the lake, by a high escarpment, the "Hill" of the region. The land between the escarpment and the lake is the Erie lowlands, the surface and soil of which are comparatively uniform. From the crest of the escarpment the land gradually ascends in an undulating, sometimes hilly plain, the "uplands" of the grape belt. The Wilcox farm is in the uplands, about 2½ miles from Lake Erie and at an altitude of 200 feet above it.

Climate.— The lowlands and uplands differ considerably in climate, due to local topography, and grape-growers in the belt generally believe that peculiarities of climate have much influence on the growth of grapes in the region. It is held, with some show of data to substantiate the belief, that the rainfall is greater and the mean temperature lower on the uplands than on the lowlands. The prevailing winds are from the west and south.

Soils.— The soils of the Chautauqua Belt are of glacial origin and contain much foreign material in the shape of boulders, small stones, gravel and finer debris. Yet, in some vineyards, the soil corresponds so closely with the rocks underneath as to indicate that the upper layer is of local origin. Practically all of the vineyards are on one or another of the several soils of the Dunkirk series. Many vineyards, as is the case with this experimental one, are growing on two or more quite distinct soils.

Vineyard plats.— The experimental vineyard is planted on two somewhat distinct soils on the Wilcox farm. One division is on Dunkirk gravel which many vineyardists believe grows grapes of

superior quality and upon which the grapes ripen a few days in advance of those on other soils. The plat on this soil contains about one acre upon which are set 600 vines. The other division of the vineyard is on Dunkirk clay, a soil more retentive of moisture than the other soils of the belt and more productive but on which the grapes are comparatively late in ripening. Of this clay land the experiment included about two-fifths of an acre, containing 225 vines. The vines behaved much the same on these two plats — quite contrary to expectations.

THE VINEYARDS.

Planting plan.— The grapes in both plats were set nine feet apart in rows eight feet apart. In the smaller plat, Plat I, there are nine rows containing twenty-five vines each; in the larger plat, Plat II, twelve rows of fifty vines each. The plan of the experiment calls for numbers of the varieties as given in the diagram on the next page.

The vineyard was laid out and planted under the general direction of Professor S. A. Beach, who planned the experiment, in May, 1902. Professor Beach directed the test until August, 1905, when the writer took charge. The original plan was to graft all vines in the vineyard and plantings of the stock for this purpose were made in late May, 1902. At this time, 225 vines each of Riparia Gloire and St. George were set in the experimental plats. The Clevener stocks could not be set until the spring of 1903.

Unfortunately a poor start was made with the vines for stocks. The plants had to be ordered from California and the long trip across the continent, with vines severely root-pruned and not good to start with, so weakened them that the loss at planting was great. Of the St. George plants 49 died and of the Riparia Gloire 206. In the fall of 1902 the vacancies in the plats of these two stocks were filled and all of the varieties on their own roots were set.

Grafting.— Grape-grafting is as old as grape-growing. At least, more or less precise methods are given for the operation in the earliest printed cultural directions for this fruit. It would seem

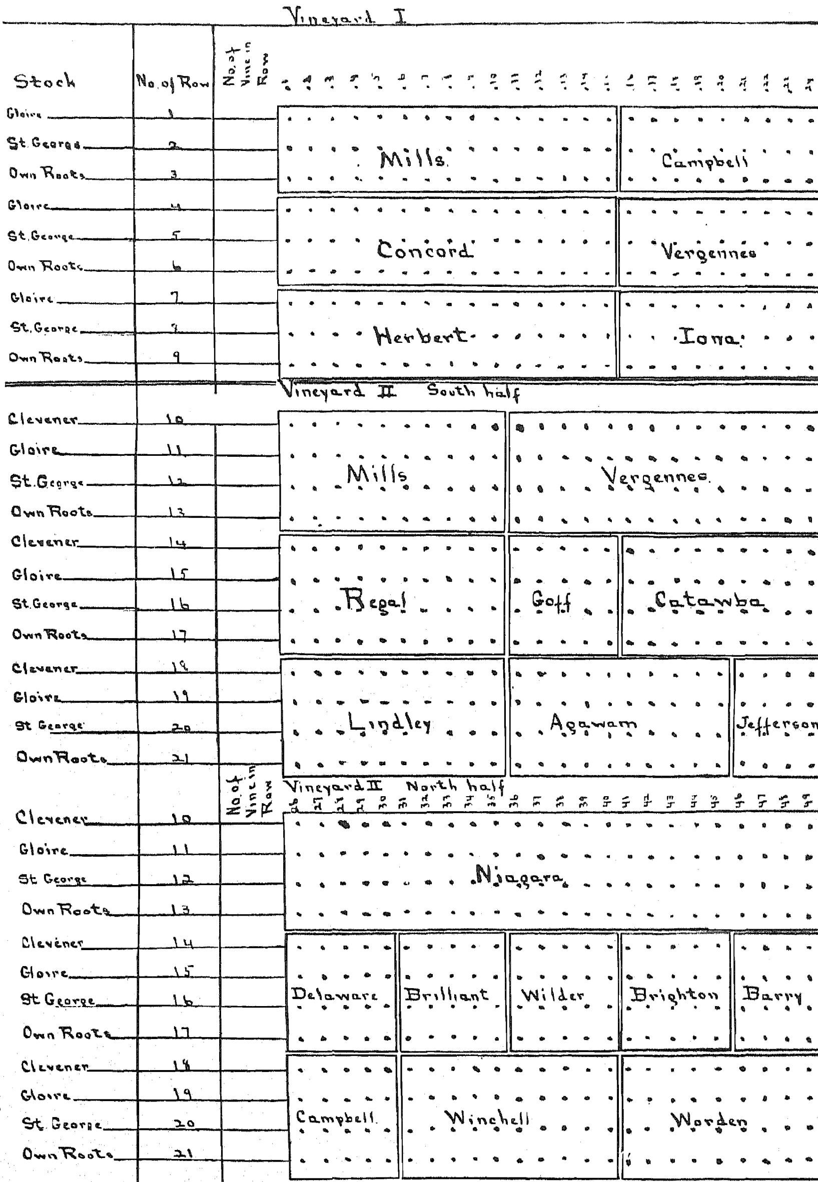


DIAGRAM I.— PLAT OF EXPERIMENTAL VINEYARDS SHOWING ARRANGEMENT OF VARIETIES.

that grafting should be a kindergarten operation in vine-growing and that all who work with grapes should know how to graft them. Yet grafted vines cannot be found in many grape regions of eastern America and grape-grafting is nowhere common. The lack of knowledge on the subject warrants a rather full description of the methods used in this experiment — a description all the more necessary because of many failures in grafting.

The original plan was to graft only on growing stocks but the loss of a large proportion of the grafted plants the first few years made it necessary to resort to bench-grafting as well. We have, therefore, two methods to describe.

Grafting on growing stocks.— The grape stocks were set in the vineyard one year before grafting. The stocks came to the Station as shown in Plate LXIV and were severely cut back, root and branch. They were planted and subsequently cared for as ungrafted grape vines are ordinarily grown. The young plants did not make a satisfactory start nor did they grow well during the summer and this unsatisfactory first season was undoubtedly the cause of many failures of vines subsequently.

The cions, each containing two eyes, were cut in the fall and buried in sand over winter. So far as appears from the records, there was no selection of cions from fertile canes or vines nor would such be the practice if the work were to be done now. At the present time in grafting, precautions are taken to procure cions from healthy, mature plants; and it is presumed that in this experiment they were thus selected. Cions from young, weakened, or diseased vines are not well lignified and do not form calluses readily, probably because of a deficiency in reserve food materials. The cions were six to eight inches long, the length depending upon that of the internodes. The average diameter was about one-third of an inch though this varied somewhat in accordance with the variety.

The first grafting was done in May, 1903. The question may well arise here as to whether this was the best time for field grafting. Subsequent experience leads to the conclusion, one also

reached by others, that the union is best if grafting be done when the stock is not in full sap. Callous tissue does not develop well when the vine is bleeding badly and the operation should, therefore, be done just before or just after the period of greatest activity of sap. If done while the sap is in full flow the rooted stock should be cut a few days before grafting. It is held in France that heavy rains during grafting are almost fatal to success and that the grafts must not be maintained under any circumstances in surroundings excessively damp.

Preparatory to grafting, the earth was removed from around the stocks to a depth of a few inches. The vines were then decapitated just below the surface of the ground and at right angles with the axis of the stock. The stock thus prepared was grafted with the ordinary cleft graft, but one cion being used, however. Precaution was taken to make the wedge of the graft at a node. After the insertion of the cion the graft was securely tied with raffia and covered with grafting wax and the vine mounded up to the upper bud of the cion with fresh earth carefully firmed. Later experiences show a much higher percentage of good grafts if grafting wax is not used, probably because the flowing sap escapes more readily. The mound is important and should be made of soil not too stiff and wet and yet firm enough to maintain an even temperature, prevent too rapid evaporation and guard the cion against being blown or knocked out.

Late in the season all of the vines were examined for a count of live and healthy plants and to remove roots which had developed from the cions. In the light of more recent experience, it is probable that the vines suffered from not having the roots of the cions removed earlier in the season — say July or August; for, since the cions were nourished partly by their own roots the root-systems of the stocks, having less to do, did not make the greatest possible growth and suffered to that extent. Eventually this probably reacted on the whole vine. The advice may be offered, in which more experienced grafters generally agree, to sever the roots of the cion as soon as possible. If the raffia has not rotted when the

roots are removed, it should be cut. It may be necessary to sever the roots of cions twice during the first season, each time earthing up as at first though not as high. The mistake was made, and here the novice will often fail, of putting some of the grafts too deep, as the result of which some vines grew on their own roots and the object of grafting was thwarted. Plate LXV shows such vines.

The earth was not leveled about the vines until the following spring, but served during the winter to protect the poorly lignified grafts from frost and to prevent blowing out of the cions. The vines were not staked the first year after grafting but this would have been a profitable precaution since a number broke either at the graft or more often just below, where the stock was frequently smaller than the cion, possibly from the fact that roots had been allowed to remain too long on the cion. Many suckers appeared from the stocks, especially from the St. George, and were removed as quickly as the work could conveniently be done. The suckering of St. George must be set down as a serious fault of this stock. Plate LXVI illustrates the suckering habit.

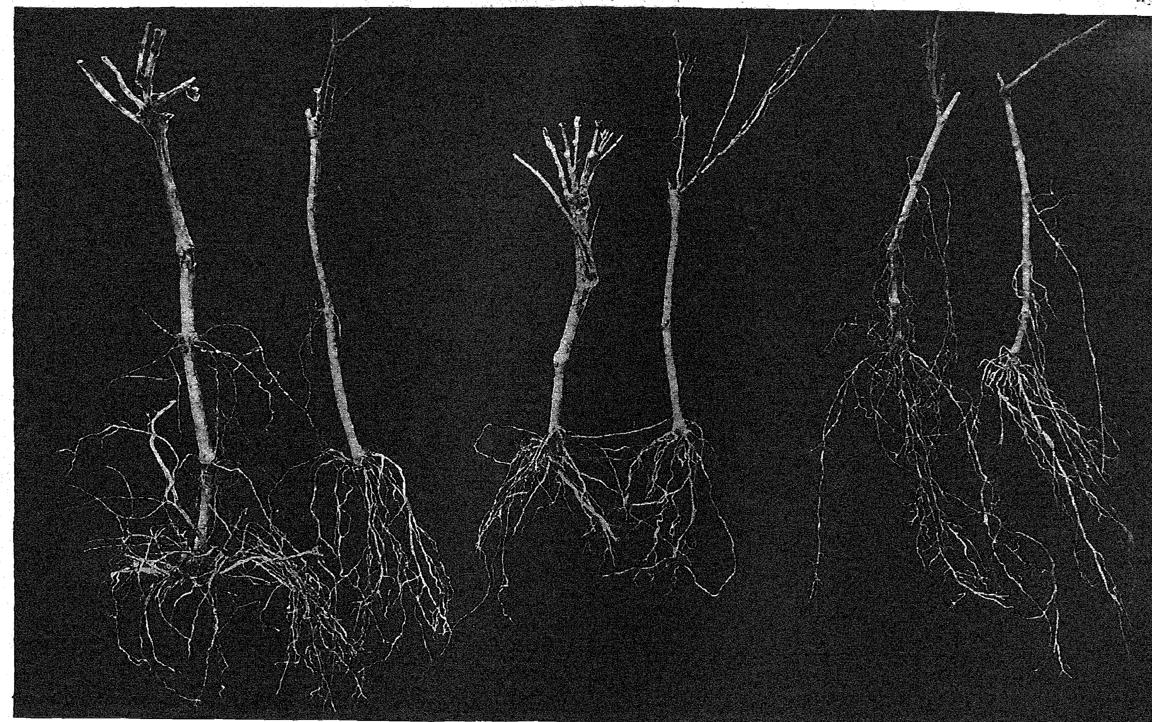
The plan to graft all vines *in situ* had to be abandoned, as before stated, because the loss of many plants made apparent the necessity of having on hand a surplus of grafted vines for the first few years of the experiment. To secure such a surplus it was necessary to resort to bench-grafting.

Bench-grafting.— The cions for the bench-grafts were prepared as for the grafting in the field. The root-stocks were the same as those set in the field but received, of course, some preliminary preparation. Roots and tops were cut back severely, the former to a few inches in length — we now cut back to an inch, for when longer they prove troublesome in handling. The mistake was made of grafting some of the stocks on the growth of the previous year the result being a great number of suckers which would not have grown, in such numbers at least, had all been grafted on the wood of the original cutting. The bench-grafting was done in late March and early April after which the grafts were stored away for callousing.

The whip-graft, known by all fruit-growers, was used in bench-grafting. Of the several methods of cutting cion and stock preparatory to uniting them, the style used was similar to the whip-grafting of nursery stock—illustrated in Plate LXVII. Grape-growers often ask what graft to use in bench-grafting. The choice must depend upon the material and the graft must be used which, with the material in hand, will best bring the cambium layer of stock and cion into juxtaposition and hold them there until the parts are firmly united. The method used in this experiment seemed to answer the purposes best and at the same time was easily performed. Of all grafts, this one mutilates and exposes the plant tissues as little as any.

A few brief statements in regard to making whip-grafts may not be out of place. The aim should be to make the cut of the stock duplicate that of the cion so that the cut surfaces cover as nearly as possible. The cut is made with one motion of the knife and with a quick, sliding movement. The length of the cut surface depends upon the diameter of stock and cion — the thinner the wood the longer the surface, which will usually be in length from three to four times the diameter of the graft. The tongues are cut and under no circumstances split. The tongue begins about one-third of the length of the beveled surface and extends a little more than one-half of the remaining surface. When stock and cion are joined, the cut surfaces should exactly cover without projections or on the other hand without any exposure of cut surface. No matter how firm the graft may seem after the parts are placed together, tying is necessary. For this purpose, use raffia or waxed string. Though the grafts for this experiment were waxed, this operation is not necessary and in fact is undesirable.

As soon as made the grafts should be placed under conditions favorable for callousing and uniting the cut surfaces, and the rooting of the stock. Favorable conditions for these vital actions can be had only in a specially prepared place where moisture, temperature and aeration can be controlled. Such a callousing bed can be made of sand or of clean sphagnum moss, in either case under



Riparia Gloire. St. George. Clevener.

PLATE LXIV.— GRAPE STOCKS AS RECEIVED.

PLATE LXV.— FORMATION OF ROOTS ABOVE UNION.
(Labels attached at point of union.)

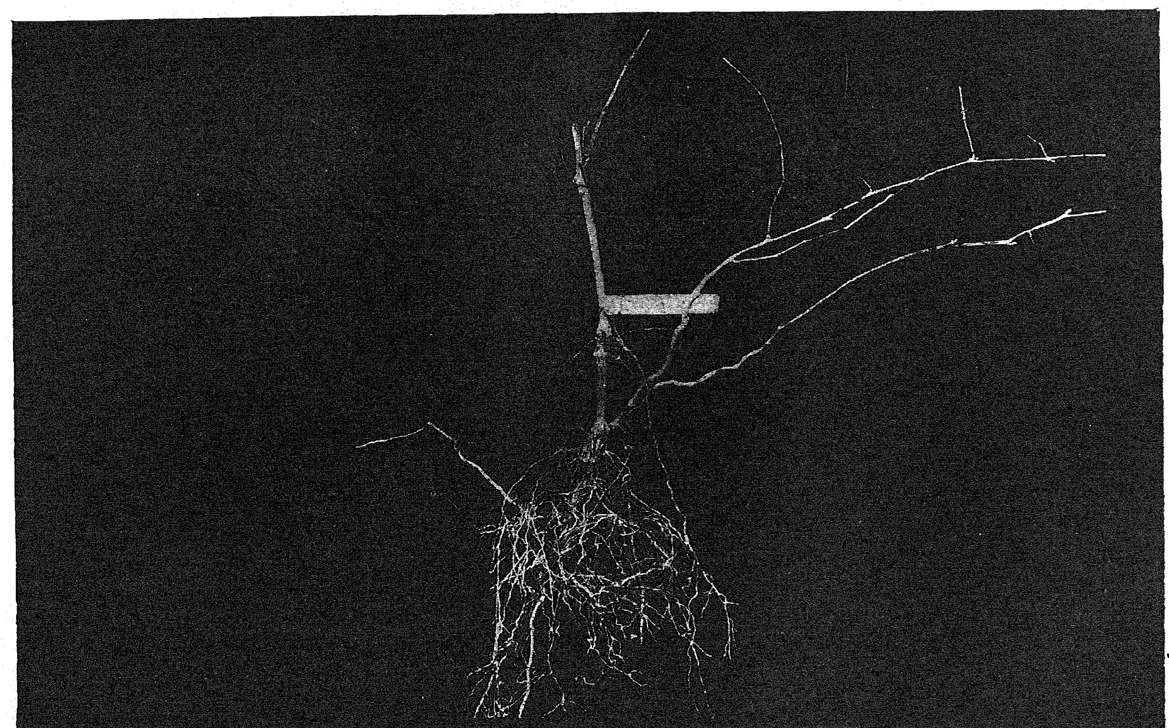


Plate LXVI.— Suckers Forming on Stock.

(Label attached to cion.)

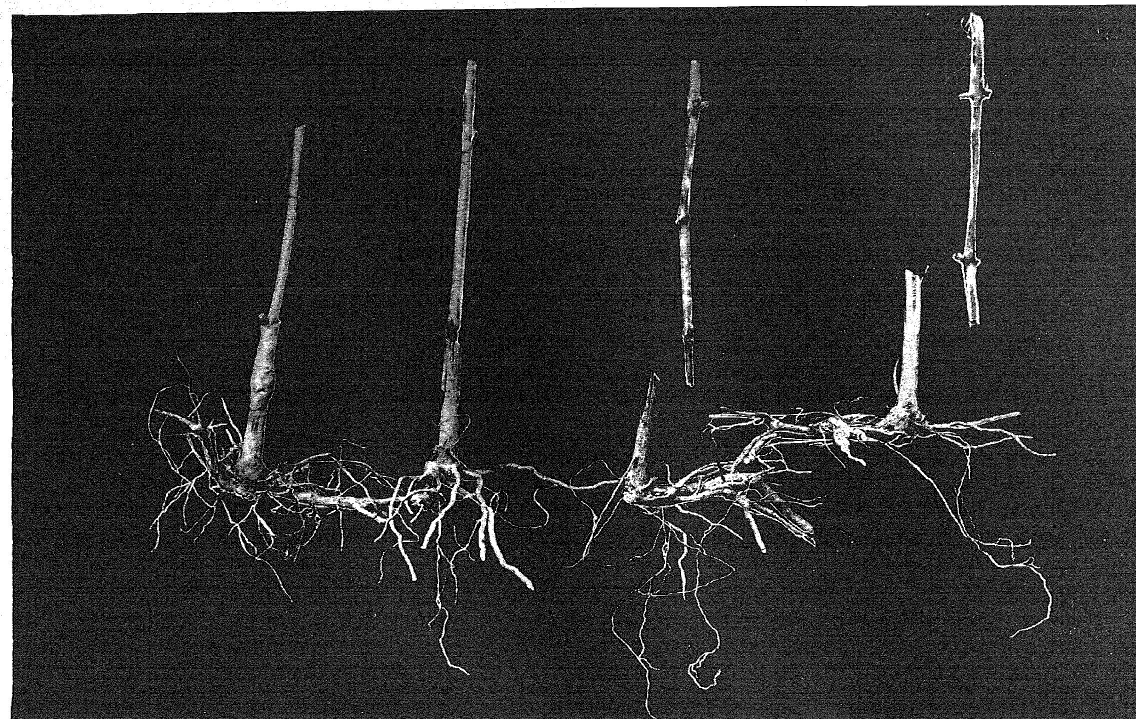


PLATE LXVII.—DIFFERENT STAGES OF GRAFTING.
(Succession is from right to left.)

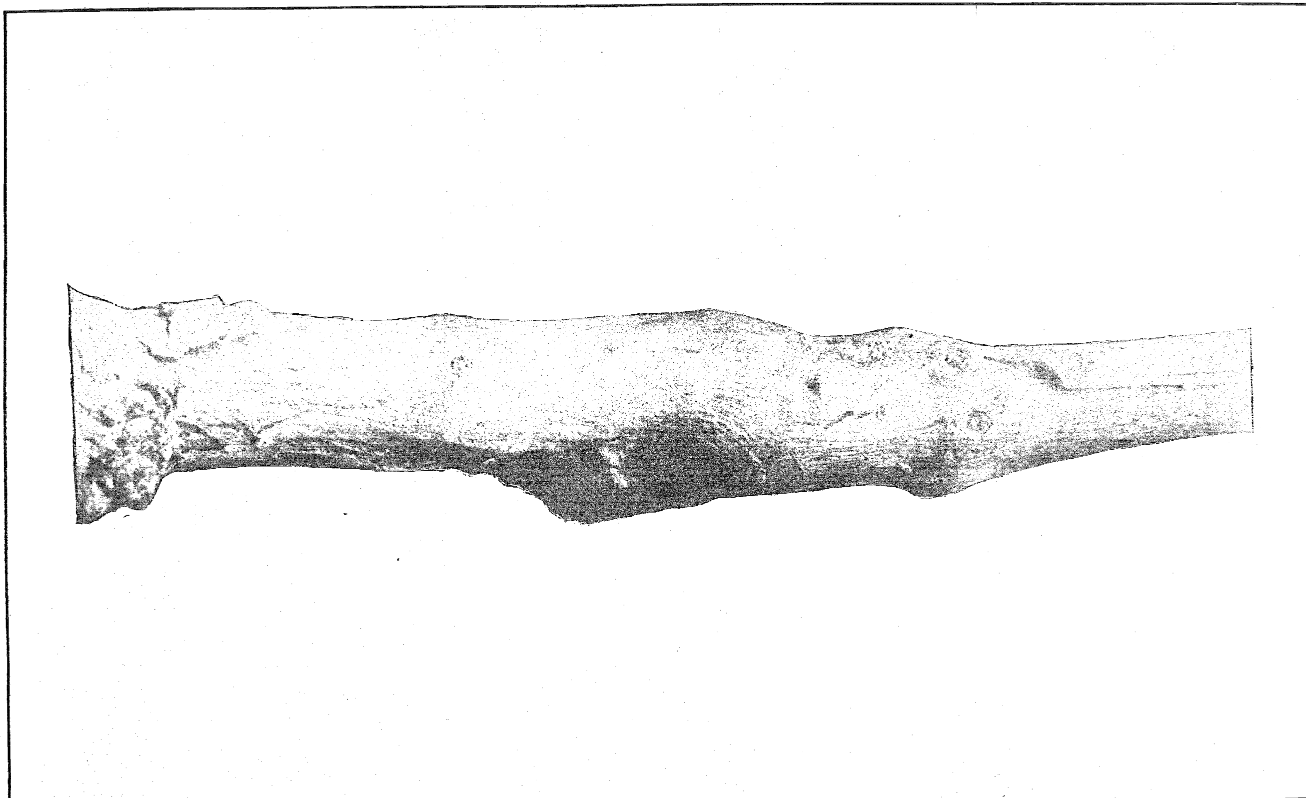


Plate LXVIII.—A Good Union of Stock and Cion.

cover. The bundles of grafts are placed in the bed, cions uppermost, and the bed is then filled with the material in the interstices in and about the bundles, to a depth of a few inches above the cions. Air there must always be. Heat and moisture can be supplied as is necessary to force or retard vital action in the grafts. At least one month is required for the formation of a proper union, such as is shown in Plate LXVIII. Finally the grafts are planted in nursery rows where care may be given them and in a soil and under conditions to make them grow vigorously.

It must not be inferred that the methods of grafting used for this experiment are necessarily the best. Any one contemplating growing a grafted vineyard would do well to study other methods. The Californians have developed vineyard graftage to a high degree and the experiment station at Berkeley, California, would probably furnish literature to the limited number that are likely to wish information on grafting grapes in New York. In that State, bench-grafting cuttings, a method not used in this experiment though now in use at this Station, is found more satisfactory than bench-grafting roots or grafting in the field. The method, so far as uniting stock and cion are concerned, is the same as that employed in bench-grafting cions on rooted cuttings.

ANNUAL REPORTS ON THE EXPERIMENT.

The progress of the experiment is best told by giving an annual report of the vineyard. The account shows that the vines have had nearly all the ills that grape flesh is heir to — some of the plants seemingly have the proverbial nine lives of a cat. The vicissitudes of the experiment are set forth in full, for unless one is conversant with them, the experimental value of the work cannot be gauged.

1902.— The vines of St. George and Riparia Gloire were set during the last few days of May. Mr. Wilcox, in charge of planting, reported, "the plants are a poor lot and not more than 50 per ct. will grow." In November the St. George vines were found to be in fair condition with but 49 dead or weak plants out of

225; of the 225 Riparia Gloire vines, 206 were dead. Late in the fall, all of the varieties on their own roots were set excepting three sorts which were put out early the next spring. For most part the vacancies in the Riparia Gloire plantation were from vines that failed to start either because originally poor stock or because weakened in the trans-continental shipment.

1903.— In the spring of this year the vacancies noted the preceding fall were filled and all of the Clevener vines were set. A surplus number of vines were bench-grafted and put in nursery rows for possible vacancies in future years. October 1 of this year, it was found that 17 Riparia Gloire stocks had died; 9 of St. George; 9 of Clevener; and 29 on their own roots. Of the grafts on Riparia Gloire 8 had died; 48 on St. George; and none on Clevener. The vines were pruned, tilled and otherwise cared for as in a commercial vineyard — this record need not be burdened with the details.

1904.— Upon examination in early May of this year many dead and weak vines were found. The greater number of these were plants on which cions had not united with the stock but which had been kept alive by roots from above the union. Most of these seemed to have been injured by the extreme cold of 1903–04. In digging plants to fill vacancies from nursery rows at the Station, it was found that the union of stock and cion was not so strong with bench-grafted plants as in the case of those grafted in the nursery row. Many of the bench-grafted plants bore roots from the cion, which were removed, and the plants set so that the union was about two inches below the surface of the ground. After planting, the vines were banked up nearly to the top of the cion. The following were the numbers reset on the different stocks: St. George, 85; Riparia Gloire, 56; on own roots, 48. All of the Clevener stock was grafted this spring, May 19 and 20. In the middle of May of this year the roots which had grown the preceding year from cions were removed. May 23 and 24, a new lot of plants were bench-grafted on the three stocks, buried until June 2 and then set in nursery rows at the experimental vineyard.

May 3, an application of acid phosphate at the rate of 600 pounds per acre and of muriate of potash at the rate of 400 pounds was made. A trellis for the plantation was erected this year.

1905.— The effects of the winter injury of 1903-04 showed more and more plainly as the season of 1904 advanced. Late in the fall the grand total of dead vines was found to be as set forth in Table I. It is not quite fair to attribute all of the deaths in the experimental plats to the severe cold but there is no other apparent reason for the wholesale dying of the vines; and grapes everywhere in the Chautauqua Belt died following this winter, so it is safe to say that those in this vineyard were almost wholly killed by cold. In the Wilcox vineyards adjoining the experimental plantations many vines, especially young ones, succumbed to the winter.

Table I.— Number and Percentage of Dead Vines of Grape Varieties Grown on Own Roots or Grafted — Spring, 1905.

Variety.	Gloire.		St. George.		Clevener.		Own roots.	
	No.	*P. ct.*	*No.*	*P. ct.*	*No.*	*P. ct.*	*No.*	*P. ct.*
Mills	8	32	2	8	8	8	25	100
Campbell	5	33	5	33	4	29	8	55
Concord	5	50	2	20	....	....	4	40
Vergennes	14	56	10	40	10	40	6	24
Herbert	6	40	2	13	....	....	4	26
Iona	2	13	3	20	....	....	3	20
Niagara	10	40	10	40	12	48	8	32
Regal	2	20	2	20	5	50	....	.....
Goff	3	30	3	30	1	10	1	10
Catawba	9	90	4	40	8	80	2	20
Delaware	1	20	3	60	4	80	3	60
Brilliant	4	80	4	80	3	60	2	40
Wilder	3	60	3	60	2	40	....	.....
Brighton	4	80	3	60	3	60	2	40
Barry	4	80	2	40	5	100	3	60
Lindley	1	10	0	00	2	20	0	00
Agawam	0	00	2	20	0	00	0	00
Jefferson	1	20	3	60	1	20	0	00
Winchell	3	30	3	30	9	90	2	20
Worden	2	20	2	20	7	70	0	00
	87	40.2	68	36.5	84	44.6	73	38.9

The numbers of vines of the several varieties are too small and the cause of death not quite certain enough to make definite statements as to what stocks and what varieties were most tender to cold; but the figures in the table may be regarded as suggestive of the hardiness to cold of stock and variety. These show that fewer vines on St. George died than on any other stock. We should not like to state it as a fact but it seems possible that the deep rooting habit of this stock may have fitted it best for withstanding cold.

After the injury of the calamitous freeze had been repaired as far as possible by resetting, old and new vines made a splendid growth in 1905, the season being most favorable. A considerable number of vines lagged in growth, however, still showing, it seemed to the observers, the effects of the cold of the winter preceding the last. As a commercial venture, and in the light of subsequent events as an experimental one, it would have been better to have dug the vines out in 1904 and to have begun anew.

1906.— The work this season began with the filling of vacancies, of which there were on Gloire stock, 34; on St. George, 27; on Clevener, 35; and on own roots, 9. The dead vines were, it may be assumed, weaklings injured by the freeze two winters past. This was the last setting made of which any account is to be taken. During the summer, as in all past seasons, the vineyard was left under thorough tillage, all suckers were removed, roots severed from cions and the best cultural treatment given. The effects of fidia, which had appeared in the vineyard a few years previous, began this year to show very perceptibly on some of the vines.

In the fall of this year for the first time a full record of the harvest was kept. A good many of the vines were not in bearing and the ages of those in fruit were so variable that the data have little value.

1907.—No items of experimental interest appear in the account of the work in the vineyard for this year. The vines are reported as making a good growth and as being free from pests of any kind excepting the fidia and this pest seemed to be succumbing to treatment and was not as bad as in previous years. During the

summer there were prospects for a good harvest but in August a hailstorm ruined the crop. The fruit was not picked as the crop had no experimental value. Even the vines were severely injured by the hail. Another episode of the year was a veritable scourge of leaf-hoppers which nearly defoliated the vines.

1908, 1909, 1910, 1911.—All vines to enter in the discussion in this Bulletin had come into bearing in or before 1908. The vineyard treatment during these years was that given commercial plantations in the Chautauqua Belt. Another disaster must be recorded for the year 1910 when a second hailstorm so damaged the crop that it could not be considered in the study of results.

RESULTS OF THE EXPERIMENT.

Grafted grapes have had a trial of eleven years in this experiment. In spite of the time that has been given to the work, of expense to meet every need of the vineyard, and of every precaution to carry on a careful trial, the results are not satisfactory. The data lack precision and fullness — lack quality and quantity. The start was on a road that seemed to lead straight ahead but there were so many obstacles in the way that progress was mostly through byways and backways. The experiment is all but a failure because of the loss of many vines at the start, because of poor stock, lack of knowledge of the best means of grafting, the freeze of 1904, the hailstorms of 1907 and 1910, and fidia.

Possibly no report should be made on an experiment that has suffered as has this one. But throughout the test the grafted vines have behaved differently from the ungrafted ones and in some respects they were better plants, so that it may be worth while to give the results of the experiment. Meanwhile we have started a similar experiment elsewhere from which we shall hope to give in time a more satisfactory report.

Grafted vines are more fertile.— Greater fruitfulness has all along characterized the grafted vines. Yet it is most difficult to show on paper precisely how much more productive the grafted vines have been. There has been but one year, 1911, in which

proper comparisons of yields could be made. Early in the life of the experiment the enormous death rate of the vines, as set forth in the annual reports, vitiated any data to be had, because of the differences in the ages of the plants, differences which became less marked as all vines came into full bearing. When a sufficient number of the vines came to an age and to a size where their products could be somewhat accurately compared, fidia and hail-storms all but ruined several crops. The data, then, to prove greater productiveness of the grafted vines will not bear critical analysis and are chiefly valuable because they substantiate the impressions of all who have worked with the experiment.

Table II shows that all grafted vines are more productive than those on their own roots. The figures in this table seem to show that the varieties on Clevener stocks are most productive, those on Gloire next, the varieties on St. George are third most productive and those on their own roots are least productive. The following is a summary: The average number of pounds per vine for the four groups of stocks are: own roots, 7.6; St. George, 10; Gloire,

TABLE II.— AVERAGE YIELD PER VINE OF OWN-ROOT AND GRAFTED GRAPE VARIETIES, 1908–1909–1911.

Variety.	Own roots.	St. George.	Gloire.	Clevener.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Niagara	8.8	14.7	15.4	13.2
Vergennes	9.6	12.6	15.5	16.1
Campbell	4.4	13.0	13.9	....
Concord	12.3	13.2	14.1	....
Regal	6.7	8.0	7.2	8.2
Catawba	10.6	11.2	13.6	13.8
Brighton	7.1	6.3	7.0	10.4
Barry	10.3	7.0	11.2	13.1
Lindley	6.9	7.9	8.0	10.0
Agawam	7.2	10.5	9.3	11.8
Winchell	6.5	10.7	11.8	14.1
Worden	5.1	7.3	9.3	8.4
Mills	......	11.4	11.5	....
Herbert	8.2	9.2	11.5	....
Iona	3.5	7.9	9.2	....

11.2; Clevener, 11.9. From these figures may be roughly calculated the number of tons per acre as follows: own roots, 2.24; St. George, 3.02; Gloire, 3.38; Clevener, 3.59.

The question at once arises: Is the greater productiveness due to an influence of the stock on the cion or to the effects of grafting acting as annular incisions, the "ringing" of the grape-grower, are known to act? This question will be taken up later.

In Table III, the yields for 1911 are given. The crop of this year was the only one borne uniformly over both experimental plats, fate this year having granted immunity from the troubles of other seasons. The figures of 1911, therefore, admit of somewhat closer analysis than those in Table II. Making the same calculations for the three stocks, the figures stand as follows: pounds per vine on own roots, 14.54; St. George, 17.72; Gloire, 17.59; Clevener, 18.60; tons per acre on own roots, 4.39; St. George, 5.36; Gloire, 5.32; Clevener, 5.62.

TABLE III.— AVERAGE YIELD PER VINE OF OWN-ROOT AND GRAFTED GRAPE VARIETIES, 1911.

Variety.	Own roots.	St. George.	Gloire.	Clevener.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Mills	16.82	16.92	16.23	15.6
Campbell	16.00	23.69	20.41	18.35
Concord	16.2	16.93	16.95	....
Vergennes	17.36	22.13	24.52	21.17
Herbert	12.21	11.89	14.95	....
Iona	15.17	16.42	17.68	....
Niagara	20.51	22.55	24.57	21.79
Regal	15.65	15.22	12.94	22.65
Goff	14.56	24.87	15.58	16.91
Catawba	15.37	12.95	16.41	21.94
Delaware	12.75	24.25	14.25	17.75
Brilliant	11.91	13.95	......	11.5
Wilder	13.87	14.18	17.08	16.18
Brighton	14.43	15.56	13.06	17.4
Barry	13.25	15.91	20.33	22.00
Lindley	10.09	10.11	10.25	13.69
Agawam	13.78	20.80	19.21	19.04
Jefferson	12.25	14.00	16.56	15.00
Winchell	18.4	25.65	27.42	29.55
Worden	10.37	16.47	15.95	15.71

No attempt is made to compare the behavior of varieties and stocks in the two vineyards on slightly different soils. There were differences; but the figures, taken under the adverse conditions of the experiment, are in no way conclusive. Beside, the experiment was not well planned for a comparison of the two vineyards, since the varieties, with but three exceptions, are different and the numbers of vines of these are not the same.

The crop on the grafted vines was increased through the setting of more bunches and the growth of larger bunches and berries. The increase in number of bunches was easily determined by actual count but for the statement regarding size we have only the fact that the proportion of unmarketable grapes was greater on the ungrafted than on the top-worked vines. The greater fertility of the varieties on other than their own roots cannot be ascribed to larger vines. No data are available as to size of vines but judging by the eye alone the grafted vines do not make as much wood as do the varieties on their own roots.

The quality of the crop, color of fruit, keeping capacity, value of the grapes for wine or grape-juice, the latter depending largely on sugar and acid content, could not be considered in this experiment though it is probable that there are greater or less differences in all these characters — and all are very important.

So far as yield, at least, is concerned, the results of this experiment are in accord with those of many experimenters abroad and in California. So, too, in this State records of grafted vineyards, collected from grape-growers and the press, show that when a grape is grafted on a congenial stock the yield is generally greater than when the variety is grown on its own roots.

Time of maturity.— The grapes on the grafted vines ripen a few days earlier than those on their own roots. This statement holds, in particular, as regards Gloire and Clevener but it is not certain that there is a constant difference in the time of ripening between the same varieties on St. George and on own roots — in fact, some varieties on the last named stock were retarded in time of maturity. Ripening notes were not kept accurately enough nor

over a sufficient number of years to permit of more than these general statements in regard to maturity. In this region where time of maturity is so important because of danger of early frost to late-ripening sorts and where it is often desirable to retard the harvest time of early grapes, it is a matter of prime importance to know accurately what influence grafting on various stocks will have on this life event. It is hoped that an experiment under way may furnish more definite information.

Behavior of vines.— It is not fair to measure the effects of a treatment by the crop alone unless the whole life of the plant is considered, when, of course, the chief criterion is crop performance. But in a period of so few years as the one in which this experiment has been in progress it is quite possible for plants to have a high record of fruitfulness but at the expense of vigor and longevity of plant. It might well be expected that grafting grapes of one species on the roots of another would have very pronounced effects on the resulting plant. Thus, amount and character of annual growth, size, color and sparsity of foliage, diameter of trunk, together with the effects on such life events as leafing-time, blooming-time, fruiting-time and fall of leaf, are indispensable to a full knowledge of any treatment of vines. The behavior of the vines may follow from the mechanical effects of grafting, which is very improbable; or from adaptability, or lack of it, of variety or stock to the environment; or to congeniality or lack of it between stock and cion. The last two factors are worth discussing.

Adaptability of stock and variety to the Chautauqua Belt conditions.— The soil, climate and all conditions of environment must be favorable to both stock and cion in a grafted vineyard — the less favorable the poorer the grapes. All the varieties chosen for this experiment, with the exception of Goff, were sorts that are grown in the Chautauqua Belt and known to be adapted to the region except in certain characters which it was hoped would do better under grafting. The stocks were untried, but the adaptability of stocks that come from largely grown species that have been thoroughly tested elsewhere can be forecasted. The stocks

chosen were those supposed to be best adapted to the region. Nevertheless the diverse needs of stock and cion as to soil and climate and their diverse behavior as to congeniality, make the behavior of the vines in the experiment a complicated problem. Table IV gives ratings indicating the vigor of varieties on the several stocks. There is no way, however, of deciding how much of the thrift of the vines listed depends on adaptability and how much on other factors.

Congeniality between stock and cion.— There must be congeniality between stock and cion in successful grafting — that is, top and root must flourish approximately as if the cion were grafted on its own roots. Knowledge of the habitats of species enables one to predict very closely whether the varieties of that species will be adapted to soil or climate, but congeniality between varieties of different species can be ascertained only by grafting the one on the other. Europeans and Californians have found that there is a great difference in the congeniality of varieties on the several stocks upon which Vinifera grapes are grafted. Without doubt we shall find similar differences in grafting grapes of American species and must ascertain by actual test what the congenialities of varieties and stocks are before running risks by grafting for large vineyards.

The failures in this experiment teach little as to congeniality for it is of course impossible to say, from the few plants worked with, whether the failures were due to lack of affinity between stock and cion or to poor material or adverse environment. Uniformly good results with a variety or a stock do indicate congeniality and adaptability to the conditions in which the vines are growing as well.

In Table IV the relative ratings given the varieties on the several stocks and on their own roots show the vigor of the vines and where high ratings are given indicate that stock and cion are congenial and that both are adapted to their environment. The percentages are averages of all the vines of the varieties and were taken in 1910 when the vineyard had reached bearing age, when

insects and fungi were well under control and before the hailstorm of that year ruined the crop. The ratings indicate vigor as judged by the eye from general appearance of vines, and amount, size and color of leaves.

TABLE IV.— RELATIVE GROWTH RATING OF GRAPE VARIETIES ON DIFFERENT STOCKS IN 1910.

Variety.	Own roots.	St. George.	Gloire.	Clevener.
Agawam	50.4	65	57.7	65.5
Barry	45	48.7	68.3	81
Brighton	55	56	73.7	75
Brilliant	53.7	66	......	50
Campbell	17.3	62.1	54.6	35
Catawba	40	74	70	81.6
Concord	46.0	94	90.7	....
Delaware	46	60	68.7	81.6
Herbert	64.6	87.5	87.1	....
Iona	26.8	45.6	43	....
Jefferson	36	38.3	57	....
Lindley	55	63	75.5	93.3
Mills	......	58.6	60.4	60 5
Niagara	53.9	84.5	57.5	56.4
Regal	17.2	58	59.4	78.8
Goff	18	80	73.3	81.6
Vergennes	44.1	77.8	69.2	90.3
Wilder	40	58	60	66
Winchell	25	52.5	52.8	53
Worden	26.1	36	61.6	38.1
	40.0	63.2	65.2	67.9

A comparison of this table with Tables II and III shows that in the main the greater productiveness of the vines agrees largely with vigor of vine. In the judgment of the writer the superiority of the grafted vines is best shown by vigor as indicated in this table. Grape-growers may well take note of the figures here set forth.

Resistance to insect and fungus pests.— Species and even varieties of grapes are very unequally subject to animal or fungus parasites. This elementary fact, impressed upon grape-growers from the earliest times, would, of course, suggest observations as to the resistance of the vines in this experiment to the various vineyard

fungi and insects. Pests there were in the vineyard in abundance, as the tales of tribulation told in the annual reports have shown, but the knowledge gained by the experimenters as to the comparative immunity of stocks and varieties is but a thing of shreds and patches and is hardly worth discussion.

Toward fungus diseases, chiefly the downy and powdery mildews, more particularly the latter though both of them were present nearly every season, the varieties, as would be expected, behaved on the grafted vines just as they did on their own roots. It has been well demonstrated in California and France that the stocks in this experiment, as well as all of the varieties on their own roots, behave differently under the attacks of phylloxera but this pest was at no time plentiful enough to furnish data for conclusions. The grape-root worm, *Fidia viticida,* has been ravaging the vineyards of the Chautauqua region for several years. The greatest disappointment in the work with this vineyard is that a detailed statement cannot be made of the differences between stocks or varieties on their own roots as to the attacks of fidia. There are differences and they are likely to prove as important with the fidia as with phylloxera, but this experiment has not furnished sufficient data to substantiate in detail the very general statement that this insect has its likes and dislikes among the stocks and varieties under trial.

How does grafting cause its effects?— The effects of grafting are so similar to those of annular incisions or injuries of any kind — greater productiveness, larger bunches and fruits, and earlier ripening — that one might well believe the mode of action to be the same. There is this difference, however — ringing acts but temporarily, only as long as the flow of sap through the cambium is interrupted, while the effects of grafting are permanent. The mechanical effect of grafting may be the same as that of ringing for the first year, or possibly two, but no longer. The similarity between grafting and ringing ceases as soon as stock and cion in the graft are completely united.

This experiment furnishes no facts as to how grafting causes its effects. It would seem, however, that it is not the operation itself

or any mechanical change but rather that it is due to some physiological disturbance. It may be due to a difference in the specific gravity in the sap of stock and cion. It may be that the food elaborated by the foliage of the cion is different from that which the stock would have had with its own foliage. Possibly it is insufficient nutrition of stock or cion. These are but conjectures as to how the vigor and productiveness are influenced. Another set of theories might be made as to causes of the varying adaptability of the grafted vines to soil and still another, as to why some rootstocks are inimical to phylloxera and fidia. They are thus briefly brought up to suggest further experimental work and to urge them, as physiological disturbances, as more probable causes than mechanical injuries.

Selection of stocks for grafting grapes.— It is necessary in seeking for a vine to be used as a rootstock to obtain a well-established variety which can be depended upon to behave in a uniform manner. Wild vines of any species would be quite too variable for practical purposes. Wild vines, too, as a rule are too slender of growth to bear the stockier cultivated grapes which when grafted on them overgrow the rootstock. The French, who have been pioneers in this work, have selected a number of strong-growing varieties of several American species and our growers are fortunate enough to have this very considerable help if they desire to try grafting. The behavior of the stocks in this experiment leads us to recommend all three for trial in commercial vineyards, though since Clevener is exceedingly hard to find it may be necessary to start with St. George and Gloire both of which may be purchased at reasonable rates from California nurserymen. To these might well be added Riparia grand glabre and the two hybrids between *Vitis riparia* and *Vitis rupestris* known as 3306 and 3309.

Procedure in growing a grafted vineyard.— Should it be demonstrated that grapes of certain varieties can be more profitably grown on other roots than on their own and that grafting grapes is profitable, nurserymen or growers must raise stocks for grafting as well as varieties for cions. It is not within the province of this

report to give full directions for growing stocks but a few suggestions derived from practice in California are printed to forestall questions that will be asked.

Of the several ways of grafting it is probable that that in which the cion and stock are grafted as cuttings will be found most satisfactory. Bioletti,[1] a leading authority on viticulture in California, compares the various methods of starting a resistant vineyard as follows:

"Bench grafting cuttings is unhesitatingly recommended for the following reasons:

"1. Both stock and scion are young and of the same size. The unions are, therefore, strong and permanent.

"2. The grafting is done under conditions favorable to rapid and effective work.

"3. The grafting can be done in any weather, and may extend over three or four months. Bench grafting may be done on rainy days when other work is not pressing or cannot be done.

"4. The work is more easily supervised. One man who thoroughly understands all details of the grafting can oversee the work of several unskilled workmen, which makes it possible to employ cheaper labor for much of the work.

"5. The cultural conditions are more easily controlled. There is much less danger of inferior results due to excessively wet or dry weather during the growing season. In the nursery the vines can be cultivated, irrigated, and generally attended to much more perfectly than in the field.

"6. A rigid selection of vines for planting can be made, rendering it possible to have nothing in the vineyard but strong plants and perfect unions.

"7. As perfect a stand can be obtained in the vineyard the first year in any soil or season as can be obtained when planting the ordinary non-resistant vines.

"8. The union of every vine can be placed exactly where we want it.

"9. The land where the vineyard is to be planted can be used for other crops for one year longer than when field grafting is adopted.

"10. All the cultural operations during the first year are much less expensive, as they are spread over a much smaller area of land. Two acres of nursery will produce enough bench grafts to plant one hundred acres of vineyard.

"In short, starting a resistant vineyard by means of bench grafts is much better than by any other method used at present because it is the least costly and gives the best results. This is true whether we produce our own bench grafts or whether we buy them at the present market rate. Growers are earnestly cautioned, however, against planting any bench grafts but the first choice. Second and third choice are little better than field grafts, and many have been offered for sale lately which are sure to give disappointment in the vineyard. There are several nurserymen in the State now who are producing No. 1 bench grafts which are equal, and for planting here perhaps superior, to any produced in Europe.

[1] Bioletti, California Sta. Bul. 180:142. 1906.

"With regard to nursery grafting and bench grafting roots, all that can be said in their favor is that they are fairly good methods when bench grafting cuttings is impracticable. They enable us to produce rooted grafts with stocks which, owing to the difficulty with which they root, are very difficult to bench graft as cuttings. By their means we are enabled to utilize resistant cuttings, which are too small to bench graft, and a larger percentage of well-grown grafted vines is obtained from the nursery.

"On the other hand, as the stock is at least two years old when grafted there is reason to fear that with some stocks many unions will fail as the vines become older. The vines are larger when they are taken from the nursery, which increases the cost of removal, and there is little if any gain in growth over bench grafts when planted in the vineyard. Finally, the method requires a year longer and is in every way more expensive.

"Of field grafting, nothing favorable can be said except that it is more generally understood and the expense and work are spread over several years instead of being principally in the first. Many of its disadvantages may be inferred from what has already been said of the advantages of bench grafting. The principal are the extreme difficulty of obtaining a perfect stand, the trouble with cion roots and stock suckers, the impossibility of detecting imperfect unions until the vines die, and finally the greater ultimate cost."

To produce cuttings for stocks mother vines must be planted and cultivated. Here, again, Bioletti gives excellent advice from which the following are extracts:

"In planting a vineyard of resistant vines for the production of cuttings to be used for grafting it is important that a suitable soil and location be chosen. In order to produce a large crop of good cuttings the soil should be naturally rich or heavily fertilized. The location should be one in which the wood always ripens early and thoroughly. Spring frosts are almost as unfavorable to the production of good cuttings as of grapes.

"All the usual stocks are vigorous growers, and as they are planted in fertile soil they should be given plenty of space. A distance of 9 feet by 9 feet or 8 feet by 10 feet is quite close enough. This will give about 500 vines to the acre. As a good vine properly cared for should produce 150 feet of good wood for bench grafting, the product of an acre would be about 75,000 cuttings.

"The varieties of resistant stocks which will in all probability be most used in California are Rupestris St. George (du Lot), Riparia X Rupestris 3306, Riparia X Rupestris 3309, Riparia Solonis 1616, Mourvedre X Rupestris 1202, Aramon X Rupestris 2, Riparia gloire, and Riparia grand glabre. These are all varieties which have given excellent results for years in Europe, and have all been tested successfully in California. Among them are varieties suitable for nearly all the vineyard soils of California, with perhaps the exception of some of the heavier clays.

"The methods of pruning and training mother vines of resistant varieties will differ in several important respects from the methods suitable for varieties grown for their fruit. In the latter case we should be careful to leave as many fruitful buds as the vine can utilize; in the former the fruit is of no value, and if any is produced it will be at the expense of the wood. Our object is to produce as much wood as possible.

"In accordance with this idea the mother vines are often pruned in such a way as to force out each year a growth of watersprouts from the old wood. All the canes on the vine are cut off as close to the stump as possible.

"It is doubtful if this is the best way. So many watersprouts are forced out that the labor and care of thinning them are expensive. If they are not thinned there is a large growth of wood, but the canes produced are short and thin, and, therefore, unsuitable for grafting stock. If this method is adopted from the beginning the vine is reduced to a prostrate stump, which makes cultivation difficult, and as the vine becomes old it becomes full of dead wood and difficult to prune.

"A better method is to give the vine a trunk and head exactly as in pruning ordinary vase-formed vines. A trunk from 15 to 18 inches high and with five or six arms will make a vine much easier to cultivate and prune and at least equally productive of good cuttings. In pruning, very short spurs are left, consisting simply of the base bud. The cane should be cut off through the first bud above the base bud. This will insure the starting of the base bud and will avoid the danger of injury which occurs when the cut is made too close to the bud which we desire to have grow.

"With this method of pruning the arms will lengthen so slowly that there will never be occasion to cut them back. During the spring and early summer all unnecessary shoots should be removed in order to throw all the vigor of the vine into those which remain.

"A good, strong vine in rich soil should produce from 150 to 300 feet of good grafting wood between one quarter and one half of an inch in diameter, and a certain amount of smaller wood good for rooting. Experience only will tell how many shoots should be left to a vine. It will depend on the age of the vine, the variety and the soil. If too few are left there is apt to be too much thick wood unsuitable for grafting, especially with certain varieties such as Rupestris St. George. If too many are left there will be too many small cuttings.

"Some varieties of stocks produce good grafting wood if the canes are allowed to grow over the surface of the ground without support. This has a tendency with some varieties to encourage the growth of laterals and to make the canes short and stocky.

"To overcome this defect high poles are sometimes placed at each vine, and the canes kept in an upright position by being tied to these poles. The poles are sometimes 15 or 20 feet high. This method produces an abundance of excellent grafting cuttings, but is expensive and troublesome. A more practical method is to put a high stake — 10 feet high at the end of each row and to stretch a wire at that height along the row. The shoots are then trained up to this wire by means of strings renewed every year."

Better care of vineyards needed for grafted grapes.— The use of grafted vines in New York vineyards will make necessary much better supplementary care in the culture of vineyards. This must not be counted in the least against grafting, for better care should be given this fruit in every grape-growing section of the State. Indeed, it is feared that the vineyardists of New York are nowadays our least caretaking horticulturists. Dead vines and somnolent vineyards are all too common. In fact, if there were no differences in yield due to the grafting, it could be said well within bounds, that since the cultivation of grapes as grafted plants enforces better care, grafting is well worth while.

Not only must better care be given to secure a good stand of vines in a grafted vineyard but different care must be given the same variety on different stocks. This will be true, very particularly, of pruning, but the stock may have to be taken into consideration in plowing, tilling, fertilizing and in treatment of phylloxera and fidia. It is true that the same treatment was given all of the vines in this experiment but only because identical treatment was a necessary condition of the experiment.

Will it prove profitable to graft grapes in New York?—Because of the many vicissitudes through which the vineyard has passed, it would not be safe to answer this question unqualifiedly. But beyond doubt the experiment demonstrates the possibility of growing grapes in this State on roots other than their own. It suggests that it would be a safe stroke of business to graft some of the choicely good grapes of the region on roots of any one of several stocks with the expectation of getting larger crops and a better product. From the behavior of the standard sorts in the experiment, it is well within the range of probability that even the main-crop grapes can be profitably grafted. A commercial plantation of a few acres of Concords, Niagaras, Catawbas or Delawares grafted on one of the three stocks used is well worth trying. The establishment of a grafted vineyard should present no great difficulties. The hard places have mostly been smoothed by the French and Californians and their experiences, with those given in this report, should be sufficient guide for any wide-awake grape-grower.

PEDIGREED NURSERY STOCK.*†

U. P. HEDRICK.

The horticulturist at an experiment station is a focus for all of the new conceits of his trade. Letters and inquiries fall upon him like the traditional thousand of brick whenever a new theory or a new practice is born which may affect crops. It is his duty to examine all of the discoveries that do not savor too much of vagary or of personal gain, and report his findings. To distinguish fairly between gold and dross requires much travail, long-continued experiments often being necessary to learn the truth, and in giving judgment the right of reversal of opinion must be held as a privilege. With this introduction, I am ready for my subject, one which of late has had much attention from fruitgrowers, nurserymen and experimenters.

"It takes three generations to make a gentleman," after which a man may record his pedigree with some pride. "Breed is more than feed," is well recognized with all domesticated animals and a horse, a cow, a pig, a dog is valued according to its pedigree. In 1862, Hallet, an Englishman, offered pedigreed wheat for sale, bred upon the same principle of repeated selection which has produced pure races of animals. "Pedigreed" seeds of plants are now very common. A genealogical tree may tell as much about the past of plants grown from seed as the pedigree of an animal tells of its ancestry. But the attempt is being made to attach importance, as in the case of men, animals and seeds, to the pedigrees of plants propagated from buds, cions, cuttings and off-shoots of plants. Thus it is claimed that varieties of tree, bush and vine fruits, propagated from parts, should have their lineage set forth before they find a place in the plantations of up-to-date planters.

To show the position held by those who believe that such plants should be passed through the sieve of selection, we make the

* Based on an address given at the meeting of the New York State Fruit Growers, Rochester, N. Y., January 5, 1912.

† A reprint of Circular No. 18, February 10, 1912.

following quotations from three horticultural authorities in the experiment stations of the country.

First horticulturist.—"We know that no two trees in any orchard are alike, either in the amount of fruit which they bear or in their vigor and habit of growth. Some are uniformly productive, and some are uniformly unproductive. We know, too, that scions or buds tend to reproduce the characters of the tree from which they are taken. Why should a fruitgrower take scions from a tree which he knows to be unprofitable?"

Second horticulturist.—"The pedigree idea rests upon the most important principle of plant breeding—that of selection. If all other plants are being improved by selection, and the improvements are handed down to their offspring, why not the fruitgrower's plants?"

Third horticulturist.—"My plan would be for a nursery to go ahead and have pedigreed trees of their own selections, which are known to produce good crops of highly colored fruit, marketable sizes, good quality, right straight along."

In the light of present knowledge, it is possible that those who gave utterance to these expressions might now repudiate them. They were, however, the beginning of the "pedigreed" stock movement and have given the vocabulary, as well as the idea, to growers of pedigreed stock. The following taken from advertisements of three nurseries offering pedigreed stock give an idea of what will come in advertising should pedigreed stock become the vogue.

First nurseryman.—"My system of pedigreeing known fruitage prepotency is revolutionizing the orchard industry and making fortunes in fruit growing sure and certain. Why gamble with trees grown from scions cut from trees which have never borne profitably? We are the only nursery in the world which grows certain pedigreed parentage exclusively—by which method we can give you the actual blood record of every tree sold you."

Second nurseryman.—"It is a decided advantage to planters to secure nursery stock propagated from the finest prize-winning trees in the West. *Quality and Pedigree certified under affidavit.*"

Third nurseryman.—"Bigger crops of better strawberries grow from pure-bred plants because for 21 years I have devoted myself,

body, brain and conscience, to upbreeding and improving the strawberry. I started right. Every year I have produced new and more productive strains. I have found that some plants show a strong tendency toward betterment. Proper breeding has enabled me to produce plants which for bearing qualities, vitality and stamina cannot be equalled."

Here, now, is a matter of tremendous importance to fruit-growers and nurserymen. If varieties of fruits can be improved by the selection of buds, cions and cuttings in propagation, the sooner the present practices in nurseries are changed the better for all who grow fruit. On the other hand if such selection of propagating wood is not worth while, it is most unjust to taboo nurserymen who cannot give the ancestry of their stock.

My own belief is that there is nothing to gain even though there be a scintilla of truth in the claims of those who would have nursery stock sold with a pedigree. I believe that we should be doing great injustice to nurserymen, and indirectly therefore to fruit-growing, should we require growers of trees to take buds or grafts only from the bearing plants which seem to be superior to other individuals of their kind. I believe that a fruitgrower can spend his time to better advantage than in attempting to breed fruit trees by bud selection. The rest of this paper is a defense of the position I have just stated.

At the very outset it must be pointed out that the seeming analogy between plants propagated from buds and cions and those grown from seeds has given a false simplicity to the facts and has led many astray. Analogy is the most treacherous kind of reasoning. We have here a case in which the similarity of properties is suggestive but the two things are wholly different upon close analysis. In the case of seeds there is a combination of definite characters in the offspring from two parents. Since the combinations of characters handed down from parents to children are never the same, individual seedlings from the same two plants may vary greatly. On the other hand a bud or a graft is literally a "chip of the old block," and while plants grown from buds may vary because of environment they do not often vary through heredity. Overwhelming objections can be urged against pedigreed nursery stock from both the plant-breeder's and the nurseryman's standpoints. In the last ten years the whole aspect of animal and plant breeding has changed in particulars which must be set forth.

Recent discoveries associated with the name of Mendel, emphasize the fundamental nature of the great force heredity in determining the characters of living things. "Like begets like," "Race is everything," "A chip of the old block," "Like father like son," "Figs cannot be picked from thistles nor grapes from thorn trees," "The iniquity of the father is visited upon the children to the third and fourth generation," are old and familiar aphorisms recalling the general nature of heredity which present knowledge makes more forceful than ever before. Heredity, in the light of Mendelism, is almost a tight compartment, a closed circle, into which new characters seldom find their way.

But new characters may get in and in their turn are inherited. How? The touchstone which Nature uses in introducing new characters into living things has long been known but has been most clearly described by De Vries. It is the phenomenon familiar to all fruitgrowers as a sport which De Vries dignifies with the name mutation. De Vries assumes that new characters in animals and plants are produced from existing forms by sudden leaps. The parent remains unchanged during this process and may repeatedly give birth to new forms.

Through the work of Mendel and De Vries old theories of breeding have been completely upset, and, in particular, we have changed our views of selection as a means of improving plants, holding that as formerly practiced it is either a worthless, a very limited, or at best a very cumbersome method of improving plants. It is now held that most of the differences in plants within the strain of the same variety or species are not transmitted from parent to offspring and that, therefore, selection with them is of no avail. There are, however, two kinds of variations and these must be described.

Not infrequently wholly new characters, the mutations of De Vries, appear in plants and are transmitted from parent to offspring. Suppose a branch of russetted, sweet or red apples in a R. I. greening tree; or a cane bearing white, or red, or seedless grapes on a Concord vine; or a branch of a Montmorency cherry bearing double flowers, to represent the kind of variations that may come true when propagated from buds or cions. Such variations are relatively rare and many men work among fruit trees a lifetime and do not find them. On the Station grounds where we have under observation eight or ten thousand tree, vine and small fruits, we seek bud-variations, but do not isolate one a year. When such a variation is found, whether or not the new

character can be transmitted to the next generation can be determined only by trial.

There are variations of another kind, much more common than those just described, due to the effect of the environment of the plant. The richer the soil, the more sunlight, the better the care, the greater the freedom from insects and diseases and the longer the season, the more vigorous is the plant, the more fruit it produces and the larger and the more perfect is the fruit. But though these changes and conditions produce a direct effect upon the plant during its lifetime, there is no evidence to show that any of the variations so brought about can be transmitted from parent to offspring. The fruitgrower who wants to perpetuate such variations, must renew for each generation the conditions which gave him the desirable effects. It is a question of "nurture" not of "nature."

To illustrate: A man living in Northern Michigan had a Spy tree which bore small, green, scrawny Spies. He attributed the poor apples to the *nature* of the tree and talked much of the Spy tree in Mother's yard "back East" that bore marvelous apples. He brought on grafts of Mother's Spy. In due time the grafts bore the same small, gnarly, green Spies. Northern Michigan Spies are worthless because of climate and soil and not because of the tree. The fruitgrower or nurseryman who attempts to raise stock from the "mother's trees," that grow in every community, will usually meet with like disappointment.

A Baldwin tree taken from New York to Virginia produces an apple different from the New York Baldwin; taken to Missouri, the Baldwin is still different; taken to Oregon, it is unlike any of the others. If the trees are brought back from these states to New York, they become again New York Baldwins. It is not likely that selection can change this.

If it were true that characters acquired because of environment were inheritable, the resulting medley would be overwhelming. Let us see where the transmission of acquired characters would lead us in a particular case — taking, it is true, a somewhat extreme one. If a growing apple be put in a bottle, it will continue to grow and will assume the shape of its covering, making a bottle-shaped apple. If one such bottle be red and another blue, the color as well as the shape of the apples will be changed. If many variously shaped and colored bottles be used and if from their seeds or buds the resulting products come true, especially if the seeds were crossed, the imagination cannot compass the confusion

in form and color of apples which would result in a few generations.

The Geneva Station has an experiment which gives precise evidences on this question of pedigreed stock. Sixteen years ago a fertilizer experiment was started with sixty Rome trees propagated from buds taken from one branch of a Rome tree. Quite as much variation can be found in these trees from selected buds as could be found in an orchard of Romes propagated indiscriminately and growing under similar conditions. Data showing the variations in diameter of tree and in productiveness can be found in Bulletin 339 of this Station, and will go far to convince any one that uniformity of behavior as regards vigor and productiveness of tree and size and color of fruit cannot be perpetuated.

We have another experiment at Geneva which ought to throw light on pedigreed stock. Baldwin apple trees have been purchased from 104 nurseries in all parts of the Union. Some of these have been propagated from bearing trees; others have come for generations from nursery stock; some are on French crab, others on Doucin, and others on Paradise stocks. If allowed to cŏme into bearing in the regions in which we obtained the trees we should have 104 more or less different trees bearing variously shaped and colored apples. What will the harvest be when all come into fruiting in the Station orchard? Will they resemble the Baldwins from the various regions from which the trees come or will they be New York Baldwins?

What I have said in regard to the improvement of fruit propagated from buds is now the accepted theory in regard to the improvement of plants grown from seed. To be of any value in plant improvement a variation must be inherited; mutations are inherited; variations resulting from environment are not inherited or at least there is no indisputable evidence of such inheritance. Fluctuating variations in vigor, hardiness, and size of plant and in color, size, amount and quality of fruit play little part in the improvement of plants. Selection was formerly considered a continuous and a cumulative process; the revised theory is that it is a discontinuous process and new characters are added in one leap. Somehow, somewhere, sometime in the life of a species of plants, a wholly new character is added, or removed, and the variation is transmissible to the succeeding generation.

May it not be true that size of fruit, vigor, hardiness or productiveness of plant may appear as mutations and be heritable? These characters may appear as heritable variations but it cannot

be known without precise experiments for each case whether or not they will be inherited. No fruitgrower or nurseryman is warranted in assuming that the qualities named can be handed down — the chances are many to one that such variations are due to nurture and are not transmissible.

For several years the speaker has spent much time in studying the histories of varieties of fruits. In "The Grapes of New York," he has had to do with about 1500 grapes; in "The Plums of New York," 2000 sorts of plums; in "The Apples of New York," with about 700 kinds of apples. When this knowledge of thousands of varieties is focused, one sees in fruits stability and not variation. The generations of varieties of fruit do not change. The Baldwin apple, Bartlett pear, Concord grape, Montmorency cherry have not changed. In the Station fruit exhibit are Greenings from a cion of the "original" Greening tree, 200 years old when the cions were taken; besides them are Greenings grown from trees propagated from nursery stock. The characters of the two lots of fruit are identical. If indiscriminate taking of buds for propagation means changes, we should have innumerable types of Baldwins, Bartletts, Concords, Montmorencies and these two lots of Greenings ought not to look alike.

There are, probably, more than one strain of some varieties of fruits, as of the Baldwin for example. But these strains are few, not more than two or three for any variety and but one in the great majority of fruits. No one knows how strains have arisen — certainly not by premeditated selection. The fact of these occasional strains does not alter the statement that the great majority of the infinitude of variations in every orchard are not transmissible.

The practical difficulties in growing trees from selected buds, granting for the minute that improved stock may be so obtained, are almost insuperable. The following are a few of them:

1st. A bearing tree surpassingly good in one quality, may be deficient in others. A tree bearing large apples might be unproductive, subject to fungi or insects, lacking in vigor or hardiness, or short-lived. Selecting for one quality will not do. The more qualities, the more difficult the tree to find and the more complicated is selection.

2nd. The selected buds must be worked, in the case of tree fruits, on roots that are variable. To have "pedigreed" trees it is necessary to have "pedigreed" roots as well as "pedigreed" tops.

3rd. The cost of trees would be vastly increased if nurserymen were required to bud from or to go back every few generations to bearing trees. Opportunities for dishonest practices would be greatly multiplied. The advertisements of some who sell "pedigreed" stock are an insult to an intelligent man and are only a foretaste of what we shall have if fruitgrowers force nurserymen to compete in selling "pedigreed" stock.

4th. It is the experience of those who have taken buds from bearing trees that the resulting nursery plants lack vigor, and remain weaklings for several years.

5th. If pedigreed trees become the vogue, tree-growing must become a petty business. Climate and environment would permit nurserymen who are growing pedigreed stock to propagate only a half dozen varieties of any fruit. Not more than this number of sorts is so pre-eminently adapted to any one geographical region as to give good mother trees.

6th. Fruit trees are not sufficiently well fixed in their characters to make selection from single "best" trees worth while even should their characters be transmissible. Thus, trees in many cases do not show their best attributes until late in life; or to the contrary fail as they grow older; or are affected for better or worse by moisture, food, or physical conditions of soil in certain seasons; or insects and fungi may give them a variable and uncertain standing. A nurseryman with the best intentions might thus propagate from a prepossessing tree only to find later that he and his customers had been deceived.

7th. Heritable variations can be told only by growing the parts bearing them — by studying the offspring, not the ancestor; by looking forward, not backward. This is impossible in the nursery.

In conclusion, the burden of proof is upon those who advocate pedigreed trees, for the present practices of propagating fruit plants are justified by the precedents of centuries. Experimenters in this field encourage us to believe that they may sometime illumine the darkness but one cannot see by the lights they have thus far brought. "The assertion that outstrips the evidence is a crime" in this case as in any other. Let us have real, precise, abundant evidence before demanding a reform that will revolutionize nursery practices.

GRAPE CULTURE.*

F. E. GLADWIN.

Location.— The ideal location for the vineyard is gently sloping land. Many fine vineyards are located on steep hillsides, yet the liability of washing and difficulty of tillage tend to render such vineyards less productive and shorter lived. The shores about the large lakes appear to be especially well adapted to grapes,— these districts in some instances extending several miles back from the water. But very rarely can grapes be grown in our northernmost latitudes without the increased labor and cost of covering in winter, except under the tempering influence of large bodies of water. Low situations that prevent a free circulation of air, such as river bottoms and the basins of small lakes, should be avoided, as such locations are more liable to unseasonable frosts; and also their poor air drainage favors powdery mildew and black rot. There is much difference of opinion as to the direction the rows should run. In the "Chautauqua Grape Belt" the prevailing direction is north and south, where the slope is not too steep. This is ideal for this section, as the morning sun rapidly dries the dew on the east side of the rows while the prevailing wind dries it on the west. The constant west and northwest wind is probably the chief reason why this district is so free from black rot. Where the slope is steep, the rows must necessarily run at right angles to it.

The foregoing does not necessarily mean that the grape can not be grown on level land, for such is not the case. Many fine, vigorous vineyards are so situated, but, as a rule, sloping land has the better natural surface drainage. The region about a large body of water is usually rolling or sloping. Hence, more vineyards are found on the slopes than on the typical flat land.

Soils.— Experience shows that grapes may be grown upon a great variety of soils. Productive vineyards are found on loam, sandy loam, gravel, gravelly loam, heavy clay and clay loam. It is not so much a question of the kind of soil, as the condition of

* A reprint of Circular No. 19, February 10, 1912.

that soil as to texture, drainage and fertility, and the possibility of washing. It is true that certain varieties exhibit a soil preference, but most commercial varieties will thrive on many types of soil.

Drainage.—The first essential is that there be good drainage. The cultivated grape does not thrive with its roots continuously in water, though it be more tolerant in this respect than most fruits. A natural conclusion prevails that sloping land is well drained; yet this is not always true. Especially where the soil is shallow, an impervious rock or hardpan below may form basins or "kettle" holes in which water is retained and the soil becomes saturated, as the water must rise to the surface to escape. Under such conditions, a slope is as badly water-logged and as poorly drained as a lowland area. If there be not good drainage, the field should be tiled.

Preparation of soil.—In the preparation of the soil for setting grape vines the grower should exercise the greatest care. A little thought and work before setting will pay for themselves many times over. As a general rule it is poor practice to reset to grapes, land that has just been in vineyard, without putting under a good green manure crop two or three times before planting. When it is desired to reset land where a vineyard has been pulled out, or even where a new location is selected, sow mammoth clover in August and plow this under just before it blossoms the following summer; then seed it again to clover and plow it under the following spring, when ready to plant. Deep turning under of a green manure crop, followed by thorough dragging and rolling, puts the soil in the best of tilth. Once gotten in good tilth after thorough preparation, it is far easier to maintain in good condition than without such preparation.

In fitting the field, preparatory to planting, plow as deeply as possible, with a two-horse plow, into lands eight or nine feet wide — the width depending on the distance apart which the rows are to be. This will leave dead furrows eight or nine feet apart. Then with a subsoil plow, go twice through each dead furrow. Much of the soil loosened by the subsoiler can now be thrown out by again going through each furrow with the two-horse plow, once each way. This insures deep planting and increases greatly the area for root growth.

Vines.— The selection of vines is an important part in the foundation of the vineyard. Too often it is neglected altogether,

by reason of the inability of the prospective grower to judge vines, or else poor vines are purchased knowingly because they are cheap. A poor vine purchased because of cheapness is a poor investment. A vineyard started with poor vines is handicapped at the start and rarely, if ever, overcomes the burden, even with good after-care.

First-grade one-year vines are to be preferred to those two years old. They are as a rule much better, though to the amateur a large vine promises more. Very frequently two-year vines represent the poorer one-year vines of the previous season transplanted and allowed to grow in the nursery row another season. Most commercial vineyards are set with one-year vines, while the amateur usually sets those two years old. There are doubtless some good two-year vines, but they are the exception.

Varieties.— The Concord is pre-eminently the commercial black grape in New York. In Chautauqua County probably 95 per ct. of the acreage is of this variety. The season of good black grapes could be considerably lengthened by planting Moore Early with Concord, as both these varieties stand up well and could be shipped to the most distant markets. Moore Early and Worden are frequently sold as Concord, as are several other black grapes. In the latitude of western New York, Moore Early ripens about ten days before Concord. If one is close to local markets, Worden should have a place in the commercial vineyard and by all means in the home vineyard. Its quality is excellent, but it will not stand shipping. It ripens about a week before Concord. Worden has proven very productive; and its clusters are large, compact, with large berries.

For red grapes, Catawba should certainly be planted where it will thoroughly ripen. It is of good quality and a good keeper. For quality, the Delaware is the grape par excellence and, with close pruning and good feeding, it is a very profitable grape. For green grapes, Winchell, or Green Mountain as it is listed by some nurserymen, should more generally be planted. This is a very early grape, of excellent quality, a good bearer of large-shouldered, compact clusters. For markets that prefer a green grape and one extremely early Winchell will find a ready sale. Niagara needs no recommendation as a market grape and, with proper care and especially allowing it to ripen fully, it will become even more popular. By the selection of varieties, black, white and red, that ripen in succession, the grower can overcome to a certain extent the frequent glutting of the market that occurs in seasons of big

crops when only one or two varieties are grown in an entire district and all are being shipped to the same markets. On the other hand he must not go to the other extreme and set too many varieties unless these can be handled in car lots or disposed of locally.

Cross-pollination.—Owing to the fact that certain varieties (self-sterile) of grapes will not form marketable clusters when planted by themselves, away from other varieties, it is necessary that the prospective grower learn whether the varieties he is setting be self-fertile or self-sterile. If he is setting both, he should alternate the two classes so as to insure pollen distribution from the self-fertile to the self-sterile. The varieties given in this Circular are all self-fertile. Never set varieties known to be self-sterile in large solid blocks.

Distance.—There are many recommendations as to distances apart for rows and vines. Some of the older vineyards are set 10 feet by 10 feet, but the prevailing distances are rows 9 feet apart and vines 8 feet. A most suitable distance appears to be 8½ feet by 8 feet, as an 8½ foot row can be plowed most satisfactorily with a three-gang plow by going twice through the row, and the subsequent tillage with spring-tooth and disc may be economically done. Many of the newer vineyards are being set 8 feet by 6 feet, and some even 8 feet by 4 feet. In this instance the grower plans to take out every other vine as soon as two or three crops have been harvested; or else to leave all and put up but half the wood per vine that is usually put up where they are 8 feet by 8 feet. But observation has shown that orchardists who have set trees closer than they should have been — intending to remove alternate trees when they arrived at maturity — find it exceedingly heartbreaking to remove a healthy bearing tree; and this, no doubt, will hold with the vineyardist who is setting 8 feet by 4 feet with the intention of pulling out each alternate vine.

Planting.— The field having been plowed in lands of the desired width, stakes are now set in the furrow at the interval decided upon for the vines in the row. These should be lined carefully each way. Then with the hoe and shovel, the hole is dug in the bottom of the furrow with the stake as the center. This can be readily done, as the plowing has loosened the soil. There is not much danger of setting the vine too deep, but rather the other extreme. The hole should be dug deep enough so that the bottom

may be filled in with surface soil, leaving a mound in the center of the hole upon which the base of the vine is to rest. It should be large enough to accommodate the roots without crowding. The roots are cut back more or less severely, depending on their growth and condition, but generally to about eight or ten inches from the base. The top is cut back to two or three buds. The roots are then spread out in the hole so that they are equally disposed in all directions, the base of the vine resting on the mound, with the roots sloping downward at quite an angle; then a little of the surface soil is tamped firmly upon them. More soil is added and firmly packed, until the hole is nearly filled, but the soil last filled in is not tamped, leaving the surface soil loose. The vine should now be deep enough so that the two or three buds of the top are just above the ground. The following winter or spring the growth of the previous season is cut back to two buds, for we should aim, above all else, to get a good, well-established root system. Then at the beginning of the second year we find our vine in apparently the same condition as the year of setting. This spring we should set the trellis posts, putting on but one wire. (See Circular 16 of this Station for trellis construction.) The trellis is not put up to fix the future training, but to get the canes out of the way for cultivation. Some fruit may set this season, but it should be removed early. The following spring the vine is ready to be trained permanently upon the trellis and a variety of systems are presented. (See Circular 16, "Pruning and Training the Grape.") The grower can choose the one he believes best suited for his varieties and local conditions. The labor problem is an important factor to be observed in this selection as it is more costly to prune and tie some systems than others.

Alleys.—When the vineyard is to cover more than three acres it is best to provide alleys or driveways for each such area, these to run both parallel and crosswise to the row. They facilitate all vineyard practices, especially cultivation and harvesting, by permitting ready access and shorter hauls. The alleys should be wide enough to permit turning with a two-horse wagon. The tendency is to provide too few alleys rather than too many.

Tillage.—Frequent and thorough tillage is very essential for the vineyard. The first spring operation is plowing under the cover crops, with the single horse and gang plows. This can be done as soon as the weather and soil conditions will permit. A single furrow is plowed up to or away from the vines on either

side of the row; then follow this with the gang plow, and, if the cover crop was particularly heavy, with the disc harrow. The three-gang plow will cover an 8½ foot row in one bout. Where no cover crop was sown, the disc may replace the plow. The subsequent cultivation is done with the grape hoe, hand hoe, spring-tooth harrow, and disc harrow. Just about the time that the root-worm has transferred to the pupa or "turtle" stage and has gotten into the upper layer of the soil, ready to emerge and, as adult, to lay its egg on the canes, the grape hoe may be used to throw a furrow away from the hills. This exposes the delicate pupal stage of the insect to the sun and other climatic conditions which are very destructive to it. Cultivate at regular intervals of ten days and always just before the soil has crusted from a rain, and especially often in a season of drought. About the first of August discontiue cultivation, the last operations being gang plowing, dragging, and plowing a single furrow up to each side of the hill. Care should be observed to keep the soil level throughout the entire width of the row during the growing season. This insures a more uniform distribution of rainfall.

Cover crops.—The vineyard should be sown to a cover crop at this time by broadcasting and dragging in with the spring-tooth harrow or else drilling it. Before sowing, it is well to watch the weather maps pretty closely and try to sow just before or just after rain. If good cultivation has been given we will have now a good seed bed. Mammoth clover, vetch, Canada field peas, clover mixed with cow-horn turnips, and winter wheat mixed with cow-horn turnips can be used. Mammoth clover sown at the rate of 20 pounds per acre has proven very satisfactory and makes an ideal nitrogenous cover crop for the vineyard. It decays rapidly and adds much nitrogen and humus to the soil.

The next most promising nitrogenous cover crops for the vineyard are hairy vetch and a mixture of mammoth clover (15 pounds) and cow-horn turnips (1 pound per acre). A mixture of winter wheat (1 bushel) and cow-horn turnips (12 ounces per acre) promises a very satisfactory non-nitrogenous cover crop.

In addition to furnishing and liberating plant food in the soil, the organic matter derived from a cover crop improves the mechanical condition and conserves moisture. A crop growing late in the fall, after the vines have ceased growing, also utilizes nitrates that are being formed then and would otherwise be lost by leaching, especially on knolls and hillsides liable to washing. There can be no doubt that the grape does best under frequent and thorough

tillage, and this means that organic matter and humus are being rapidly burned out of the soil. Hence the loss must be supplied by the use of stable manure, cover crops, or organic commercial fertilizer.

Intercropping.—Many growers grow potatoes, cabbage, beans, etc., between the rows of the young vineyard for the first two years, while others interplant blackberries, raspberries, currants, gooseberries and strawberries for indefinite periods. Observation shows that neither of these plans is in keeping with the best vineyard practices; and both the primary and secondary crops suffer as the result of such systems. The only crop that should be allowed in the vineyard is the cover crop.

Fertilizers.—The fertilizers required by the grape are still largely a matter of experiment, and until this phase is thoroughly worked out, the grower must rely on his vines to tell him what is needed. Even should the wood growth indicate a lack of nitrogen, it would not indicate that more nitrogen should be added to the soil, as there might be a sufficiency already present, yet unavailable by reason of poor tillage, lack of drainage and other faulty practices.

Manuring.—The above statements will apply equally well to the use of stable manure. It is probable that stable manure does produce vigorous wood growth in some instances and it is just as probable that its direct fertilizing value has been overestimated. Its greatest value lies in its power to improve the mechanical condition of the soil by making it more porous and increasing its water-holding capacity.

Spraying.—Spraying for grape insects has been fully discussed in Bulletin No. 331 of this Station, so that nothing need be added here. Everyone growing grapes should procure a copy of this bulletin.

No person should attempt to grow grapes for pleasure or for profit, unless he is willing to and can give them proper care. The history of grape growing has been, and is to-day, one of ups and downs, and what the specific reasons are for the fluctuations is unknown. Possibly a combination of causes is responsible. In every region of decline there are many vineyards that are holding up to the standard. Why? In all such vineyards the grower has given personal supervision and intelligent care and has not attempted to get a great yield one year at the expense of none the

next, but has been satisfied to produce a fair crop each year. This should be the aim of each grower. Excessive wood growth is not desired, nor an excessive yield in alternate years, but a balance should be struck between these extremes.

F. E. GLADWIN.

NEW YORK AGRICULTURAL EXPERIMENT STATION,
GENEVA, N. Y., Feb. 10, 1912.

REPORT

ON

INSPECTION WORK.

I. Analyses of materials sold as insecticides and fungicides.

II. Inspection of feeding stuffs.

III. Report of analyses of commercial fertilizers collected by the Commissioner of Agriculture during 1912.

ANALYSES OF MATERIALS SOLD AS INSECTICIDES AND FUNGICIDES.†

PARIS GREEN.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Arsenious oxide.	Copper oxide.	Water-soluble arsenious oxide.
					Per ct.	*Per ct.*	*Per ct.*
866	80	Adler Color & Chemical Co., New York City,	New York City	G*	50	—	3.50
		"Strictly pure S. S. F. Paris green".		F*	56.79	29.04	5.13
795	—	Alpha Chemical Co., New York City,	Poughkeepsie	G	—	—	—
		"Strictly pure Paris green"		F	55.71	28.55	7.90
753	16	A. B. Ansbacher & Co., New York City,	Albany	G	50	—	3.50
		"Paris green"		F	55.99	29.06	—
796	394	E. J. Barry, New York City,	Poughkeepsie	G	50	30	3.50
		"Strictly pure Paris green"		F	57.10	29.41	3.60
790	198	Jas. A. Blanchard, New York City,	Poughkeepsie	G	50	—	3.50
		"Lion" brand		F	56.75	27.29	4.85
808	—	Lewis Burger & Son, London, Eng.,	Newburgh	G	—	—	—
		"Pure Paris green"		F	57.63	29.86	7.34
873	33	Childs & Sons, New York City,	New York	G	50	—	3.50
				F	57.40	29.59	2.35
807	1 and 2	Devoe & Reynolds Co., New York City,	Newburgh	G	59.40	29.37	1.48
		"Strictly pure Paris green"		F	57.74	29.31	4.15
799	20	Fred L. Lavenburg, New York City,	Poughkeepsie	G	50	—	3.50
		"Strictly pure Star brand"		F	57.55	29.24	3.88
776	40	Leggett & Bro., New York City,	Albany	G	50	—	3.50
		"Warranted strictly pure Paris green"		F	56.61	29.44	3.05

* G and F stand respectively for Guaranteed and Found.

† A reprint of Bulletin No. 348, May, 1912.

PARIS GREEN—(*Concluded*).

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Arsenious oxide.	Copper oxide.	Water-soluble arsenious oxide.
					Per ct.	*Per ct.*	*Per ct.*
836	154–213–348	John Lucas & Co., New York City,	Medina	*G	55	——	——
		"Warranted strictly pure Paris green"		*F	56.99	28.96	5.54
752	27	Morris, Herrmann & Co., New York City,	Albany	G	50	——	3 50
		"Hi-grade pure Paris green"		F	56.74	29.01	5.40
787	27	Morris, Herrmann & Co., New York City,	Troy	G	50	——	3.50
		"Hi-grade pure Paris green"		F	57	29.16	2.49
754	214	I. Pfeiffer, New York City,	Albany	G	50	——	3.50
		"Strictly pure Paris green"		F	56.66	29.17	5.82
788	259	Sherwin-Williams Co., New York City,	Troy	G	56	——	2 00
		"Strictly pure Paris green"		F	56.87	29.44	4.02
837	76–259	Sherwin-Williams Co., New York City,	Medina	G	56	——	2.00
		"Strictly pure Paris green"		F	57.34	29.37	3.74

* G and F stand respectively for Guaranteed and Found.

LEAD ARSENATE.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Arsenic oxide.	Lead oxide.	Water-soluble arsenic.
					Per ct.	*Per ct.*	*Per ct.*
811	81	Adler Color & Chemical Co., New York City,	Newburgh	G	30	—	—
		"Eagle" brand		F	30.30	64.71	0.53
755	157	A. B. Ansbacher & Co., New York City,	Albany	G	12.50	—	—
		"Triangle" brand		F	15.50	32.59	0.60
791	201	Jas. A. Blanchard Co., New York City,	Poughkeepsie	G	15	—	—
		"Lion" brand		F	13.88	35.71	0.72
879	—	F. W. Devoe & C. T. Reynolds Co., New York City,	New York City	G	—	—	—
		"Dry"		F	19.44	39.47	2.86
793	54	Grasselli Chemical Co., Cleveland, Ohio,	Poughkeepsie	G	15	—	—
		"Grasselli arsenate of lead"		F	16.19	40	0.30
810	155	Hemingway's London Purple Co., London, Eng., and New York,	Newburgh	G	15	—	—
		"Pure lead arsenate"		F	15.99	31.14	0.29
882	155	Hemingway's London Purple Co., London, Eng., and New York,	Chatham	G	15	—	—
		"Pure lead arsenate"		F	17.86	34.15	0.40
801	300	Interstate Chemical Co., Jersey City, N. J.,	Poughkeepsie	G	15.50	—	—
		"Key" brand		F	16.92	33.23	0.39
878	300	Interstate Chemical Co., Jersey City, N. J.,	New York City	G	15.50	—	—
		"Key" brand		F	17.24	33.04	0.37
798	21	Fred Lavenburg, New York City,	Poughkeepsie	G	15	—	—
		"Star" brand		F	15.92	32.63	0.75
777	86	Leggett Bros., New York City,	Albany	G	14.50	—	—
		"Anchor" brand		F	15.10	31.20	0.59
762	291	Merrimac Chemical Co., Boston, Mass.,	Albany	G	30	—	—
		"Swift's arsenate of lead"		F	29.42	64.89	0.73
881	291	Merrimac Chemical Co., Boston, Mass.,	Chatham	G	30	64	
		"Swift's arsenate of lead"		F	30.8	64.43	0.35

* G and F stand respectively for Guaranteed and Found.

LEAD ARSENATE—(*Concluded*).

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Arsenic oxide.	Lead oxide.	Water-soluble arsenic.
					Per ct.	*Per ct.*	*Per ct.*
839	128	Niagara Sprayer Co., Middleport, N. Y., "Niagara" brand	Middleport	*G	15	—	—
				*F	12.66	27.30	0.43
817	—	Powers, Weightman, Rosengarten, New York and Philadelphia, "Lead arsenate"	Kingston	G	—	—	—
				F	12.59	41.83	0.14
818	—	Powers, Weightman, Rosengarten, New York and Philadelphia, "Lead arsenate"	Kingston	G	—	—	—
				F	17.58	46.78	0.50
835	—	F. W. Devoe & C. T. Reynolds Co., New York City, "Arsenate of lead, dry"	Brockport	G	—	—	—
				F	19.40	44.20	3.00
779	135	Schoonmaker & Son, Cedar Hill, N. Y., "Aiboneta"	Troy	G	4	—	—
				F	6.42	21.77	0.17
784	256	Sherwin-Williams Co., Cleveland, Ohio, "New process"	Troy	G	12.50	—	—
				F	14.93	33.03	0.71
806	113	Thompson Chemical Co., Baltimore, Md., "Orchard" brand	Newburgh	G	15	—	—
				F	16.39	31.10	0.52
832	121	Vreeland Chemical Co., Little Falls, N. J., "Electro arsenate of lead"	Rochester	G	20	—	—
				F	19.20	39.00	0.18
833	—	Vreeland Chemical Co., Little Falls, N. J., "Dry arsenate of lead"	Rochester	G	30	—	—
				F	32.76	63.07	0.44

BORDEAUX LEAD ARSENATE.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Arsenic oxide.	Lead oxide.	Copper oxide.
876	185	Bowker's Insecticide Co., Boston, Mass., "Pyrox"	New York City	G	6.75	17	2.0
				F	8.44	17.42	3.1
831	210	Vreeland Chemical Co., Little Falls, N. J., "Electro Bordo-lead mixture"	Rochester	G	6.08	—	6.8
				F	10.46	22.5	2.6

* G and F stand respectively for Guaranteed and Found.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Copper oxide.
					Per ct.
868	79	Adler Color & Chemical Co., New York City,	New York City	*G	16.3
		" Eagle " brand		*F	14.2
867	78	Adler Color & Chemical Co., New York City,	New York City	G	6.5
		" Eagle brand concentrated Bordeaux paste "		F	6.0
756	17	A. B. Ansbacher & Co., New York City,	Albany	G	20.0
		" Bordeaux mixture "		F	15.8
789	200	Jas. A. Blanchard Co., New York City,	Poughkeepsie	G	20.3
		" Lion " brand		F	17.8
861	56	Grasselli Chemical Co., New York City,	Portchester	G	5.9
		" Grasselli "		F	6.0
865	48	Benjamin Hammond, Fishkill, N. Y.,	Mt. Vernon	G	21.5
		" French Bordeaux mixture "		F	16.4
874	29	Morris, Herrmann & Co., New York City,	New York City	G	——
		" Bordeaux mixture "		F	14.8
767	39	Leggett & Bro., New York City,	Albany	G	16.0
		" Dry Bordeaux mixture "		F	15.2
794	42	Leggett & Bro., New York City,	Poughkeepsie	G	6.3
		" Anchor " brand		F	5.7
786	——	Sherwin-Williams Co., Cleveland, Ohio,	Troy	G	8.1
		" Sherwin-Williams "		F	8.2
845	208	Target Brand Co., Martinsburg, W. Va.,	Ransomville	G	13.0
		" Target " brand		F	12.5
830	211	Vreeland Chemical Co., Little Falls, N. J.,	Rochester	G	7.8
		" Electro Bordo Pulp "		F	4.0

* G and F stand respectively for Guaranteed and Found.

BORDEAUX-PARIS GREEN MIXTURE.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Arsenious oxide.	Copper oxide.	Water-soluble arsenious oxide.
					Per ct.	*Per ct.*	*Per ct.*
780	—	The Bowker Insecticide Co., Boston, New York, Cincinnati, "Boxal"	Troy	*G	—	—	—
				*F	11.44	13.8	5.66
774	42	Leggett & Bro., New York City, Dry Bordeaux mixture and Paris green	Albany	G	—	—	—
				F	18.6	18.6	8.82
783	145	Schoonmaker & Son, Cedar Hill, N. Y., "Tux-E-do mixture"	Troy	G	—	—	—
				F	2.69	5.9	1.77

* G and F stand respectively for Guaranteed and Found.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Sulphur in solution.	Density	Sediment.
					Per ct.	*Degs. B.*	*Per ct.*
809	199	Jas. A. Blanchard, New York City,	Newburgh	*G	20	—	—
		"Lion brand concentrated lime sulphur solution"		*F	21.28	30.8	—
823	134	A. B. Clark, Milton, N. Y.,	Milton	G	—	—	—
		"Lime and sulphur solution"		F	20.26	29.3	1.60
771	93	Grasselli Chemical Co., Cleveland, Ohio,	Albany	G	23.65	—	—
		"Lime-sulphur solution"		F	25.49	33.3	—
792	93	Grasselli Chemical Co., Cleveland, Ohio,	Poughkeepsie	G	23.65	—	—
		"Lime-sulphur solution"		F	25.45	32.9	—
768	79	Benjamin Hammond, Fishkill, N. Y.,	Albany	G	—	—	—
		"Lime-sulphur and salt, Horricum"		F	22.89	—	—
843	298	A. B. Hayes, Gasport, N. Y.,	Gasport	G	—	27	—
		"Lime-sulphur solution"		F	18.79	28.9	1.50
820	171–327	J. A. Hepworth, Milton, N. Y.,	Milton	G	—	26	—
				F	17.64	26.6	2.00
847	—	Horticultural Chemical Co., Philadelphia, Pa.,	Ransomville	G	—	—	—
		"Lime-sulphur solution"		F	23.82	32.8	—
848	299	Leggett & Bro., New York City,	Rochester	G	25	33	—
		"Anchor brand lime-sulphur"		F	25.53	32.5	—
816	—	Nathan Moore, Ghent, N. Y.,	Chatham	G	—	—	—
		"Lime-sulphur"		F	28.59	37.4	35.22
841	126	Niagara Sprayer Co., Middleport, N. Y.,	Middleport	G	25	—	—
		"Niagara lime and sulphur solution"		F	27.72	35.8	—
851	126	Niagara Sprayer Co., Middleport, N. Y.,	Hilton	G	25	—	—
		"Niagara lime and sulphur solution"		F	26.27	34.4	1.39
815	—	T. F. Niles, Chatham, N. Y.,	Chatham	G	—	—	—
				F	19.62	29.5	—

* G and F stand respectively for Guaranteed and Found.

LIME-SULPHUR SOLUTION—(*Concluded*).

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Sulphur in solution.	Density	Sediment.
					Per ct.	*Degs. B.*	*Per ct.*
825	109	Rex Company, Rochester, N. Y.,	Albion	*G	——	——	——
		"Rex lime and sulphur solution"		*F	26.16	33.9	——
822	205	T. F. Sears, Milton, N. Y.,	Milton	G	——	27	——
		"Star" brand		F	21.12	29.9	5.15
782	258	Sherwin-Williams Co., Cleveland, Ohio,	Troy	G	25	——	——
		"S-W. Lime-sulphur-solution"		F	25.58	33	——
821	——	F. W. Vail, Milton, N. Y.,	Milton	G	——	——	——
				F	15.65	25.4	4.75
850	212	Vreeland Chemical Co., Little Falls, N. J.,	Rochester	G	23	——	——
		"Lime-sulphur solution"		F	26.72	34.4	——

* G and F stand respectively for Guaranteed and Found.

MIXTURE OF SOLUBLE SULPHUR AND OILS.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Soluble sulphur.
					Per ct.
856	——	Aphine Manufacturing Co., Madison, N. J.,	Elmsford	*G	——
		"Fungine"		*F	4.62
872	——	Bogart Chemical Co., New York City,	New York	G	——
		"Sulphur compound"		F	9.35
880	297	Charles Fremd, North Rose, N. Y.,	North Rose	G	——
		"Sulco-V. B."		F	8.84
772	192	B. G. Pratt Co., New York City,	Albany	G	29
		"Sulfocide"		F	31.90

* G and F stand respectively for Guaranteed and Found.

NICOTINE PREPARATIONS.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Nicotine.
					Per ct.
804	243	Aphine Manufacturing Co., Madison, N. J., "Aphine"	Newburgh	*G	0.90
				*F	0.89
877	118	Detroit Nicotine Co., Detroit, Mich., "To-Bac-Ine"	New York	G	45
				F	43.17
775	150	Kentucky Tobacco Product Co., Louisville, Ky., "Nico-Fume"	Albany	G	40
				F	40.48
781	151	Kentucky Tobacco Product Co., Louisville, Ky., "Nico-Fume Tobacco Paper Insecticide"	Troy	G	—— (1,008 grains per package).
				F	6.39 (273.9 grains per package).
828	148	Kentucky Tobacco Product Co., Louisville, Ky., "Black Leaf 40"	Rochester	G	40
				F	40
870	149	Kentucky Tobacco Product Co., Louisville, Ky., "Rose Leaf Extract of Tobacco"	New York	G	2.70
				F	3.77
814	248	Larkin & Co., Buffalo, N. Y., "Sulpho-Tobacco Soap"	Newburgh	G	——
				F	0.54
826	117	Nicotine Manufacturing Co., St. Louis, Mo., "Nikoteen Aphis-Punk"	Rochester	G	—— (700 grains per package).
				F	7.96 (239.5 grains per package).
829	115	P. L. Palethorp Co., Owensboro, Ky., "Nicoticide"	Rochester	G	25
				F	45.30
875	——	G. H. Richards, London, Eng., "X L all"	New York	G	——
				F	3.41
864	——	H. A. Stoolhoff Co., Mt. Vernon, N. Y., "Tobacco Dust"	Mt. Vernon	G	——
				F	0.95

* G and F stand respectively for Guaranteed and Found.

SOAP SOLUTION.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Soap.	Water.	Total alkali.	Impurities.
					Per ct.	*Per ct.*	*Per ct.*	*Per ct.*
805	314	Jas. A. Blanchard, New York City,	Newburgh	*G				
		"Lime Brand Whale Oil Soap"		*F	90.00	7.64	8.85	2.36
824	240	James Good, Philadelphia, Pa.,	Rochester	G				
		"Whale Oil Soap"		F	85.30	10.66	8.60	3.94
852	238	James Good, Philadelphia, Pa.,	Hilton	G				
		"Whale Oil Soap"		F	86.95	8.46	8.24	4.59
863	83	Leggett & Bro., New York City,	Mt. Vernon	G				
		"Anchor Brand Fish Oil Soap"		F	84.38	9.99	7.71	5.63
800	——	Lehn & Finch, New York City,	Poughkeepsie	G				
		"Whale Oil Soap"		F	81.14	10.25	9.09	8.61
778	——	George A. Price, Albany,	Albany	G				
		"Stott's Fir Tree Oil Soap"		F	†71.12	23.73	5.91	0
785	156	Schoonmaker & Son, Cedar Hill, N. Y.,	Troy	G				
		"Caustic Soda Arctic Whale Oil Soap"		F	86.15	11.61	6.00	1.44
759	232	Walker & Gibson, Albany, N. Y.,	Albany	G				
		"Fish Oil Soap"		F	91.96	6.75	8.93	1.29

* G and F stand respectively for Guaranteed and Found.

† Contains also 5.15 per ct. of phenol (carbolic acid).

SULPHUR.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.		Total sulphur.
					Per ct.
803	4–5	Battelle & Renwich, New York City,	Poughkeepsie	*G	100
		" Brooklyn Brand Flour Sulphur "		*F	99.44
842	——	Niagara Sprayer Co., Middleport, N. Y.,	Middleport	G	——
		" Pure Flowers of Sulphur "		F	99.62
763	——	Walker & Gibson, Albany, N. Y.,	Albany	G	——
		" Sulphur "		F	99.38
764	——	Walker & Gibson, Albany, N. Y.,	Albany	G	——
		" Flowers of Sulphur "		F	98.94
819	6–13	T. & S. C. White, New York City,	Kingston	G	99.90
		" Powdered Sulphur "		F	98.34

* G and F stand respectively for Guaranteed and Found.

HELLEBORE.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.	
859	——	James A. Blanchard Co., New York City, " Lion " brand	Tarrytown	All samples were tested qualitatively for helleborein. The characteristic deep-red color was obtained in case of each sample. The microscopical appearance of all samples was similar. All the samples had the appearance of being genuine hellebore.
797	——	Huber & Furman Drug Co., Fondulac, Mich., " White Hellebore "	Poughkeepsie	
760	132	Leggett & Bro., New York City, " Anchor " brand	Albany	
802	108	Park Davis & Co., Detroit, Mich., " Powdered Hellebore "	Poughkeepsie	
862	——	J. M. Thorburn Co., New York City, " Pure Powdered Hellebore "	Mt. Vernon	
758	164	Walker & Gibson, Albany, N. Y., " Hellebore "	Albany	

MISCELLANEOUS MATERIALS AND MIXTURES.

Sample number.	Certificate number.	Name and address of manufacturer and trade name or brand.	Where taken.	
834	——	Bannerman Chemical Co., Syracuse, N. Y., "Poison green"	Brockport	Calcium arsenite, artificially colored; containing 38.4 per ct. arsenious oxide.
757	153	Danforth Chemical Co., Leominster, Mass., "Bug Death"	Albany	Contains zinc oxide, lead oxide, iron, calcium, phosphorus, potassium compounds, etc.
838	——	Farmers' Industrial Union, Syracuse, N. Y., "Green Death"	Medina	Calcium arsenite, artificially colored; contains 35.94 per ct. of arsenious oxide.
860	25	Benjamin Hammond, Fishkill, N. Y., "Copper solution"	Albany	Ammoniacal solution of copper carbonate, containing 4.97 per ct. of copper oxide.
857	24	Benjamin Hammond, Fishkill, N. Y., "Grape Dust"	Tarrytown	Contains free sulphur, tobacco, copper sulphate, calcium sulphate.
761	26	Benjamin Hammond, Fishkill, N. Y., "Slug Shot"	Albany	Contains free sulphur, copper sulphate, calcium sulphate, iron oxide, tobacco, arsenic and carbolic acid.
773	66	Benjamin Hammond, Fishkill, N. Y., "Thrip Juice"	Albany	A potash resin soap, containing 2.64 per ct. of arsenious oxide.
812	65	Hemingway's London Purple Co., London, Eng., "London Purple"	Newburgh	Contains 22.57 per ct. of arsenious oxide and 19.92 per ct. of arsenic oxide.
769	14	B. G. Pratt Co., New York City, "Scalecide"	Albany	Mixture of mineral and vegetable oils with naphthaline.
827	143	Schoonmaker & Sons, Cedar Hill, N. Y., "Fresno"	Rochester	Ammoniacal solution of copper carbonate, containing 2.69 per ct. of copper oxide.
766	——	Walker & Gibson, Albany, N. Y., "Blue Vitriol"	Albany	Contains 97.22 per ct. of copper sulphate cryst.
765	——	Walker & Gibson, Albany, N. Y., "Copperas"	Albany	Sulphate of iron.

INSPECTION OF FEEDING STUFFS.‡

This bulletin gives the results of the analyses† of samples of feeding stuffs collected by the Commissioner of Agriculture during the fall and winter of 1911–12 and by him transmitted for analysis to the Director of the New York Agricultural Experiment Station, in accordance with the provisions of Article VII of the Agricultural Law. These analyses are published by the Director of the New York Agricultural Experiment Station in accordance with the provisions of section 164 of said Article.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	Per ct.	Per ct.
	COTTONSEED MEALS:				
1475	Alabama Cotton Oil Co., Selma, Ala. "Prime Cotton Seed Meal"	South Byron	G* 41. F* 37.75	9. 6.58	7. 8.21
3990	The American Cotton Oil Co., Little Rock, Ark. "Choice Cottonseed Meal"	Ithaca	G 41. F 41.19	9. 7.76	10.50 7.59
4369	American Cotton Oil Co., Little Rock, Ark. "Choice Cottonseed Meal"	Pawling	G 41. F 42.19	9. 7.15	10.50 9.46
4232	The American Cotton Oil Co., New York, N. Y. "Prime Cotton Seed Meal"	Monroe	G 38.61 F 39.19	8. 6.98	11.50 9.06
4227	American Milling Co., Chicago, Ill. "Amco Cottonseed Meal"	Florida	G 41. F 41.38	8. 8.92	10. 7.12
4300	The Bartlett Co., Detroit, Mich. "Bartlett's Farmer Brand Fancy Choice Cotton Seed Meal"	Rochester	G 41. F 42.37	7. 8.58	10. 5.10
3242	H. E. Bridges & Co., Memphis, Tenn. "Cotton Seed Meal"	Watertown	G 41. F 39.88	9. 7.14	9. 7.69

* These letters indicate, respectively, Guaranteed and Found.

† The analyses herewith published are made in charge of the Chemical Department of the Station, the immediate oversight of the work being assigned to E. L. Baker, Associate Chemist.

‡ A reprint of Bulletin No. 351, September, 1912.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	COTTONSEED MEALS:				
4383	H. E. Bridges & Co., Memphis, Tenn. "Cotton Seed Meal"	Unadilla	G* 41. F* 43.25	9. 8.14	9. 5.34
4405	H. E. Bridges & Co., Memphis, Tenn. "Cotton Seed Meal"	Rochester	G 41. F 41.94	9. 8.51	9 6.31
4266	F. W. Brode & Co., Memphis, Tenn. "Dove Brand Cotton Seed Meal"	Deposit	G 38.62 F 41.56	6. 9.72	10. 6.74
4028	F. W. Brode & Co., Memphis, Tenn. "Dove Brand Cotton Seed Meal"	Malone	G 38.62 F 39.69	6. 8.11	10. 9.03
3842	F. W. Brode & Co., Memphis, Tenn. "Owl Brand High Grade Cotton Seed Meal"	Medina	G 41. F 40.94	6. 7.53	10. 5.70
3963	F. W. Brode & Co., Memphis, Tenn. "Owl Brand High Grade Cotton Seed Meal"	Greene	G 41. F 41.10	6. 6.85	10. 8.50
4002	F. W. Brode & Co., Memphis, Tenn. "Owl Brand High Grade Cotton Seed Meal"	Fulton	G 41. F 43.88	6. 8.70	10. 7.78
3938	F. W. Brode & Co., Memphis, Tenn. "Owl Brand Pure Cotton Seed Meal"	Alexander	G 41. F 41.60	6. 11.60	10. 5.86
4102	F. W. Brode & Co., Memphis, Tenn. "Owl Brand Pure Cotton Seed Meal"	Altamont	G 41. F 41.	6. 7.35	10. 7.55
3818	The Buckeye Cotton Oil Co., Cincinnati, O. "Buckeye Prime Cottonseed Meal"	Brooklyn	G 38.50 F 40.50	6.50 8.04	10. 7.51
4093	The Buckeye Cotton Oil Co., Cincinnati, O. "Buckeye Prime Cottonseed Meal"	Moravia	G 39. F 40.	6.50 6.86	10. 7.24

* These letters indicate, respectively, Guaranteed and Found.

Analyses of Samples of Feeding Stuffs — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	Cottonseed Meals:				
4386	The Buckeye Cotton Oil Co., Cincinnati, O. "Buckeye Prime Cottonseed Meal"	Cherry Valley	G* 39. F* 40.81	6.50 7.46	10. 7.93
3989	Chapin & Co., Buffalo, N. Y. "Green Diamond Brand Choice Cotton Seed Meal"	Cortland	G 41. F 41.60	8. 7.38	10. 7.49
4546	Chapin & Co., Hammond, Ind. "Green Diamond Brand Choice Cotton Seed Meal"	Hurleyville	G 41. F 42.94	8. 10.56	10. 4.89
4292	S. P. Davis, Little Rock, Ark. "Good Luck Brand Cottonseed Meal Cracked Screened Cake"	Berkshire	G 41. F 41.06	7. 8.33	10.50 6.53
4482	The Dewey Bros. Co., Blanchester, O. "Queen Cotton Seed Meal"	Auburn	G 41. F 43.81	7. 8.48	10. 5.46
4099	Humphreys, Godwin & Co., Memphis, Tenn. "Dixie Brand Cotton Seed Meal"	Elmira	G 38.62 F 42.25	6. 11.05	12. 5.44
4189	Humphreys, Godwin & Co., Memphis, Tenn. "Dixie Brand Cotton Seed Meal"	Castile	G 38.62 F 41.06	6. 7.77	12. 7.55
4224	Humphreys, Godwin & Co., Memphis, Tenn. "Dixie Brand Cottonseed Meal"	Chester	G 38.62 F 39.63	6. 6.55	12. 8.56
3930	Imperial Cotto Milling Co., Memphis, Tenn. "Imperial Cotto Brand Choice Cotton Seed Meal"	Clarence	G 41. F 41.06	7.50 7.17	14. 6.93
4370	Keeton-Krueger Co., Atlanta, Ga. "Peacock Brand Cotton Seed Meal"	Brewster	G 41. F 44.19	6. 8.30	10. 5.98
4500	Keeton-Krueger Co., Atlanta, Ga. "Choice Peacock Brand Cotton Seed Meal"	S. New Berlin	G 41. F 40.94	6. 11.85	10. 6.31

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.
				Per ct.	*Per ct.*	*Per ct.*
	COTTONSEED MEALS:					
4483	Keeton-Krueger Co., Atlanta, Ga. "Peacock Brand Cotton Seed Meal"	Fayetteville	G* F*	41. 41.38	6. 8.01	10. 7.16
4138	Kemper Mill & Elevator Co., Kansas City, Mo. "Choice Cottonseed Meal"	Cooperstown	G F	41. 41.25	7.50 8.42	10. 5.15
4171	Kemper Mill & Elevator Co., Kansas City, Mo. "Choice Cotton Seed Meal"	Medina	G F	41. 39.19	7.50 6.75	10. 7.66
4091	Memphis Cottonseed Products Co., Memphis, Tenn. "Selden Cottonseed Meal"	Groton	G F	41. 39.19	6. 9.70	10. 7.04
3983	W. C. Nothern, Little Rock, Ark. "Bee Brand Cotton Seed Meal Cake"	Whitney's Pt.	G F	41. 38.37	7. 7.51	10.50 7.82
4320	W. C. Nothern, Little Rock, Ark. "Bee Brand Cotton Seed Meal Cake"	Angelica	G F	41. 43.05	7. 7.54	10.50 5.76
4541	J. E. Soper Co., Boston, Mass. "Pioneer Cotton Seed Meal"	Middleburgh	G F	41. 40.19	7. 7.60	10. 8.06
4269	J. Lindsay Wells Co., Memphis, Tenn. "Star Brand Prime Finely-Ground Cotton Seed Meal"	Oxford	G F	38.50 41.56	6. 9.49	11. 5.66
4373	J. Lindsay Wells Co., Memphis, Tenn. "Star Brand Prime Finely-Ground Cotton Seed Meal"	Poughkeepsie	G F	38.50 40.50	6. 9.09	11. 6.37
	LINSEED MEALS:					
3914	American Linseed Co., New York, N. Y. "Old Process Oil Meal"	Batavia	G F	32. 38.57	5 5.59	7. 6.41
3972	American Linseed Co., New York, N. Y. "Old Process Oil Meal"	Vestal	G F	32. 38.16	5. 5.18	7. 7.33

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	LINSEED MEALS:				
4016	American Linseed Co., New York, N. Y. "Old Process Oil Meal"	Madrid Springs	G* 32. F* 39.19	5. 5.89	7. 7.63
4106	American Linseed Co., New York, N. Y. "Old Process Oil Meal"	Central Bridge	G 32. F 38.70	5. 5.13	7. 6.78
4447	American Linseed Co., New York, N. Y. "Old Process Oil Meal"	Canandaigua	G 34. F 37.13	5. 5.78	8. 8.03
4425	Archer-Daniels Linseed Co., Minneapolis, Minn. "Ground Oil Cake"	Waverly	G 32. F 37.13	6. 6.61	10. 6.96
4382	Chapin & Co., Buffalo, N. Y. "Pure Linseed Oil Meal"	Richfield Springs	G 33. F 37.38	5. 5.80	10. 6.41
3926	Hauenstein & Co., Buffalo, N. Y. "Old Process Linseed Meal"	Akron	G 30. F 36.60	5. 6.72	[illegible] 6.87
4296	Hauenstein & Co., Buffalo, N. Y. "Old Process Linseed Meal"	Geneva	G 30. F 36.44	5. 7.61	10. 7.41
4549	Hirst & Begley Linseed Co., Chicago, Ill. "Linseed Meal"	Troy	G 34. F 38.56	8. 9.39	9. 7.08
4014	Kelloggs & Miller, Amsterdam, N. Y. "Pure Old Process Oil Meal"	Boonville	G 33. F 37.19	5. 7.37	7.5 6.75
4124	The Guy G. Major Co., Toledo, O. "Old Process Oil Meal"	Oneonta	G 30. F 27.43	5. 5.64	10. 8.65
4366	The Mann Bros. Co., Buffalo, N. Y. "Old Process Linseed Oil Meal"	Millerton	G 34. F 38.63	6. 7.25	10. 6.89
4279	The Mann Bros. Co., Buffalo, N. Y. "Pure Old Process Linseed Oil Meal"	Hamilton	G 34. F 37.50	6. 7.71	10. 7.29

*These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	LINSEED MEALS:				
3988	The Metzger Seed and Oil Co., Toledo, O. "Old Process Oil Meal"	Cortland	G* 30. F* 33.56	5. 6.34	10. 8.21
4132	The Metzger Seed and Oil Co., Toledo, O. "Old Process Oil Meal"†	Oneonta	G 30 F 27.88	5. 6.13	10. 7.64
4179	The Metzger Seed & Oil Co., Toledo, O. "Old Process Oil Meal"†	Wilson	G 30. F 27.88	5. 6.58	10. 8.63
4182	The Metzger Seed & Oil Co., Toledo, O. "Old Process Oil Meal"†	Geneseo	G 30. F 28.88	5. 6.62	10. 7.58
4185	The Metzger Seed & Oil Co., Toledo, O. "Old Process Oil Meal"†	Dalton	G 30. F 27.81	5. 7.34	10. 7.57
4187	The Metzger Seed & Oil Co., Toledo, O. "Old Process Oil Meal"	Portageville	G 30. F 35.	5. 6.10	10. 7.62
4184	National Feed Co., St. Louis, Mo. "Pure Old Process Linseed Meal"	Nunda	G 34. F 37.13	7. 8.64	7. 6.61
4022	The Sherwin-Williams Co., Cleveland, O. "Linseed Oil Meal"	Castorland	G 33. F 39.31	6. 6.52	8. 7.36
4308	The Sherwin-Williams Co., Cleveland, O. "Oil Meal"	Alfred Station	G 33. F 38.75	6. 7.88	8. 6.68
	MALT SPROUTS:				
3247	American Malting Co., Buffalo, N. Y. "Malt Sprouts"	Mexico	G 25. F 28.32	.019 1.68	14. 9.79
3819	American Malting Co., New York, N. Y. "Malt Sprouts"	New York	G 25. F 25.88	1.90 1.47	14. 14.40
3949	American Malting Co., Buffalo, N. Y. "Malt Sprouts"	Arcade	G 25. F 27.47	.019 1.80	14. 11.94

* These letters indicate, respectively, Guaranteed and Found.
† Contains flax screenings.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	MALT SPROUTS:				
4134	American Malting Co., Buffalo, N. Y. "Malt Sprouts"	Hartwick	G* 25. F* 25.	1.90 1.50	14. 11.17
4151	Atlantic Export Co. of Wis., Chicago, Ill. "Malt Sprouts"†	Arcade	G 25. F 24.81	1.5 1.98	12. 12.23
4452	Atlantic Export Co. of Wis., Chicago, Ill. "Malt Sprouts"	Sauquoit	G 25. F 25.06	1.5 1.53	12. 13.69
4234	P. Ballantine & Sons, Newark, N. J. "Malt Sprouts"	Monroe	G 25.02 F 25.63	1.69 1.47	—— 12.77
4018	M. F. Baringer, Philadelphia, Pa. "Malt Sprouts"‡	Lowville	G 25. F 24.	1.60 1.83	13. 11.46
4450	Bartholomay Brewery Co., Rochester, N. Y. "Malt Sprouts"†	Rochester	G 21. F 24.94	2.26 2.15	18.91 12.26
3929	H. V. Burns, Buffalo, N. Y. "Malt Sprouts"	Clarence	G 23.70 F 23.66	2.70 1.65	14. 13.04
4161	Chapin & Co., Hammond, Ind. "Marvel Malt Sprouts"	Alden	G 22. F 24.94	2. 1.54	13. 11.14
4281	Chapin & Co., Hammond, Ind. "Marvel Malt Sprouts"	Valley Mills	G 22. F 23.62	2. 1.96	13. 12.81
4225	Donahue-Stratton Co., Milwaukee, Wis. "Hiquality Malt Sprouts"	Chester	G 25. F 26.56	1.50 1.76	14. 10.83
4578	Donahue-Stratton Co., Milwaukee, Wis. "Hiquality Malt Sprouts"	Alexander	G 25. F 25.37	1.50 1.43	14. 14.19
3979	Francis Duhne, Jr., Milwaukee, Wis. "Malt Sprouts"	Waverly	G 25. F 26.78	2. 1.55	11. 11.65

* These letters indicate, respectively, Guaranteed and Found.
† Contains a few weed seeds.
‡ Contains a considerable amount of weed seeds and grit.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	MALT SPROUTS:				
4013	Francis Duhne, Jr., Milwaukee, Wis. "Malt Sprouts"	Holland Patent	G* 25. F* 30.69	2. 1.99	11. 11.71
4577	The Fleischman Malting Co., Buffalo, N. Y. "Malt Sprouts"	Buffalo	G 24. F 26.13	1. 1.69	11. 12.71
4298	Geneva Malting Co., Geneva, N. Y. "Malt Sprouts"†	Geneva	G 26.50 F 25.69	2.45 2.23	10.49 11.28
4137	F. W. Goeke & Co., St. Louis, Mo. "Malt Sprouts"†	Cooperstown	G 23. F 23.81	2. 2.	16. 12.75
4424	F. W. Goeke & Co., St. Louis, Mo. "Malt Sprouts"‡	Waverly	G 23. F 27.56	2. 2.03	16. 14.96
4305	John Kam Malting Co., Buffalo, N. Y. "Malt Sprouts"	South Wales	G 25. F 28.38	1.50 1.62	16. 13.21
4575	Kreiner & Lehr Buffalo, N. Y. "Malt Sprouts"†	Buffalo	G 22. F 26.38	1.50 1.99	12.89 13.39
4247	Lembeck & Betz Eagle Brewing Co., Watkins, N. Y. "Malt Sprouts"†	Johnsons	G 28.08 F 30.75	1.65 2.01	11.12 9.57
4255	Lembeck & Betz Eagle Brewing Co., Watkins, N. Y. "Malt Sprouts"‡	Watkins	G 28.08 F 31.81	1.65 1.64	11.12 10.82
4597	C. C. Lewis, Buffalo, N. Y. "Malt Sprouts"§	North Collins	G 25. F 27.19	2. 1.97	11. 8.51
3942	C. H. McLaughlin, Suspension Bridge, N. Y. "Malt Sprouts"	Attica	G 26.50 F 22.44	2.45 1.92	10.49 11.86
4274	C. H. McLaughlin, Buffalo, N. Y "Malt Sprouts"‡	New Berlin	G 26.50 F 26.75	2.45 2.12	10.49 10.73

* These letters indicate, respectively, Guaranteed and Found.
† Contains weed seeds.
‡ Contains a few weed seeds.
§ Contains weed seeds and coal dust.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	MALT SPROUTS:				
4277	Geo. J. Meyer Malting Co., Buffalo, N. Y. "Malt Sprouts"†	New Berlin	G* 20.82 F* 31.37	1.4 2.02	14. 9.79
4576	Geo. J. Meyer Malting Co., Buffalo, N. Y. "Malt Sprouts"†	Buffalo	G 20.82 F 31.31	1.4 2.12	14. 12.72
4526	Milwaukee Malting Co., Milwaukee, Wis. "Malt Sprouts"	Port Chester	G 25. F 25.56	1.50 1.60	17. 11.88
4477	Hiram M. Mirick Lyons, N. Y. "Malt Sprouts"†	Lyons	G —— F 28.44	—— 2.15	—— 12.96
4584	Henry C. Moffat, Buffalo, N. Y. "Malt Sprouts"	Buffalo	G 25. F 33.94	1.60 2.01	12. 9.50
4456	Neidlinger & Co., Oswego, N. Y. "Malt Sprouts"	Oswego	G 26.25 F 27.81	.70 1.60	9.75 12.05
3839	Perot Malting Co., Buffalo, N. Y. "Malt Sprouts"	Buffalo	G 23. F 24.88	.50 1.76	18. 12.07
4245	Perot Malting Co., Buffalo, N. Y. "Malt Sprouts"	Middletown	G 25. F 29.81	1.10 1.89	16. 11.87
3218	M. G. Rankin & Co., Milwaukee, Wis. "Jersey Malt Sprouts"	Potsdam	G 25. F 30.20	1.50 2.26	17. 10.31
3246	M. G. Rankin & Co., Milwaukee, Wis. "Jersey Malt Sprouts"	New Haven	G 25. F 26.97	1.50 1.51	17. 10.45
4379	M. G. Rankin & Co., Milwaukee, Wis. "Jersey Malt Sprouts"†	Edmeston	G 25. F 26.81	1.50 1.71	17. 11.22
4498	M. G. Rankin & Co., Milwaukee, Wis. "Malt Sprouts"†	New Berlin	G 25. F 27.75	1.50 1.53	17. 11.31

* These letters indicate, respectively, Guaranteed and Found.
† Contains weed seeds.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	MALT SPROUTS:				
4421	Wm. Taylor, Lyons, N. Y. "Malt Sprouts"†	Lyons	G* 26. F* 23.50	1.75 2.48	5. 12.75
4217	Thompson & Mould, Goshen, N. Y. "Malt Sprouts"	Goshen	G 25. F 26.94	1.50 2.05	18. 10.43
4242	Thompson & Mould, Goshen, N. Y. "Malt Sprouts"	Middletown	G 25. F 25.69	1.50 1.39	18. 12.55
4273	Thompson & Mould, Goshen, N. Y. "Malt Sprouts"	New Berlin	G 25. F 26.63	1.50 1.52	18. 12.28
3937	Forrest Utley Co., Dixon, Ill. "Malt Sprouts"	Alexander	G 24. F 24.28	2. 1.59	7. 13.85
4562	The C. Zwickel Malting Co., Buffalo, N. Y. "Malt Sprouts"†	Buffalo	G 25. F 30.33	2. 1.77	11. 11.69
	DRIED DISTILLERS' GRAINS:				
4176	A. E. Co., New York, N. Y. "Distillers' Rye Grains"	Le Roy	G —— F 20.81	—— 8.24	—— 9.86
3219	Ajax Milling & Feed Co., New York, N. Y. "Ajax Flakes"	Potsdam	G 30. F 32.04	10. 12.13	14. 9.75
3923	Ajax Milling & Feed Co., New York, N. Y. "Ajax Flakes"	S. Alabama	G 30. F 31.59	11. 13.15	14. 8.31
3986	Ajax Milling & Feed Co., New York, N. Y. "Ajax Flakes"	Cortland	G 30. F 32.32	11. 11.06	14. 10.31
4130	Ajax Milling & Feed Co., New York, N. Y. "Ajax Flakes"	Oneonta	G 30. F 30.13	11. 12.25	14. 9.75
4454	Atlantic Export Co. of Wis., Chicago, Ill. "Atlantic Grains"	Sauquoit	G 30. F 29.94	8. 11.09	12. 9.89

* These letters indicate, respectively, Guaranteed and Found.
† Contains weed seeds.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	DRIED DISTILLERS' GRAINS:				
4459	M. F. Baringer, Philadelphia, Pa. " Pure Distillers' Dried Grains "	Deansboro	G* 31. F* 32.06	12. 13.18	13. 7.83
4264	The J. W. Biles Co., Cincinnati, O. " Distillers' Dried Rye Grains "	Deposit	G 16. F 17.44	5. 8.49	16. 11.44
4598	The J. W. Biles Co., Cincinnati, O. " Distillers' Dried Rye Grains "	Steamburg	G 16. F 16.69	5. 8.57	16. 12.14
3978	The J. W. Biles Co., Cincinnati, O. " Fourex Distillers' Dried Grains "	Waverly	G 31. F 31.25	12. 12.60	13. 11.50
4001	The J. W. Biles Co., Cincinnati, O. " XXXX Fourex Grains "	Fulton	G 31. F 29.54	12. 13.63	13. 6.79
4116	The J. W. Biles Co., Cincinnati, O. " Fourex Distillers' Dried Grains "	Worcester	G 31. F 32.56	12. 14.80	13. 10.46
4177	The J. W. Biles Co., Cincinnati, O. " Fourex Distillers' Dried Grains "	Le Roy	G 31. F 29.31	12. 12.78	13. 8.52
4415	B. J. Burns Co., Buffalo, N. Y. " Overall Distillers' Dried Grains "	Syracuse	G 30. F 32.63	10. 11.17	14. 9.25
4038	Chapin & Co., Buffalo, N. Y. " A A A Distillers' Grains "	Waterville	G 27. F 29.	8. 11.05	16. 9.73
4168	Chapin & Co., Buffalo, N. Y. " A A A Distillers' Grains "	Darien	G 27. F 31.63	8. 9.15	16. 9.88
4267	Chapin & Co., Buffalo, N. Y. " 3-A Distillers' Grains "	Oxford	G 27. F 29.69	8. 11.57	16. 10.16
4065	The Clifton Springs Distilling Co., Cincinnati, O. " Imperial Corn Distillers' Grains "	Norwich	G 28. F 33.06	8. 14.10	29. 11.28

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	DRIED DISTILLERS' GRAINS:				
4147	The Clifton Springs Distilling Co., Cincinnati, O. "Imperial Corn Distillers' Grains"	Oneonta	G* 28. F* 33.75	8. 12.59	29. 14.44
4291	The Clifton Springs Distilling Co., Cincinnati, O. "Imperial Corn Distillers' Grains"	Nichols	G 28. F 34.25	8. 13.74	29. 11.65
4294	Columbia Distilling Co., Waterloo, N. Y. "Distillers' Dried Grains."	Waterloo	G 25. F 34.94	8. 13.30	14. 10.47
4012	Continental Cereal Co., Peoria, Ill. "Continental Gluten Feed"†	Holland Pat'nt	G 31. F 32.	13.5 14.06	8.5 6.43
4064	Continental Cereal Co., Peoria, Ill. "Continental Gluten Feed"†	Norwich	G 31. F 32.	13.5 13.46	8.5 6.3
4162	Continental Cereal Co., Peoria, Ill. "Continental Gluten Feed"†	Alden	G 31. F 32.50	13.5 13.47	8.5 6.26
4239	Continental Cereal Co., Peoria, Ill. "Continental Gluten Feed"†	Wisner	G 31. F 31.94	13.5 13.78	8.5 5.96
3228	The Dewey Bros. Co., Blanchester, O. "Corn 3 D Grains"	Antwerp	G 26. F 28.88	9. 11.84	13. 6.87
3955	The Dewey Bros. Co., Blanchester, O. "Corn 3 D Grains"	Binghamton	G 26. F 27.34	9. 10.36	13. 6.41
4122	The Dewey Bros. Co., Blanchester, O. "Eagle 3 D Grains"	Oneonta	G 30. F 32.57	10. 10.13	13. 9.05
3236	The Dewey Bros. Co., Blanchester, O. "Eagle 3 D Grains"	Adams	G 30. F 33.59	10. 13.01	13. 10.29
3936	The Dewey Bros. Co., Blanchester, O. "Eagle 3 D Grains"	Alexander	G 30. F 31.53	10. 13.59	13. 9.99

* These letters indicate, respectively, Guaranteed and Found.
† Dried distillers' grains.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	DRIED DISTILLERS' GRAINS:				
4341	The Dewey Bros. Co., Blanchester, O. "Eagle 3 D Grains"	Springville	G* 30. F* 30.19	10. 12.94	13. 11.89
4098	The Dewey Bros. Co., Blanchester, O. "Buckeye Gluten Feed" †	Harpursville	G 20. F 18.63	5. 5.71	15. 12.04
4334	The Dewey Bros. Co., Blanchester, O. "Buckeye Gluten Feed" †	Franklinville	G 20. F 21.37	5. 4.62	15. 10.07
4384	The Dewey Bros. Co., Blanchester, O. "Queen 3 D Grains" †	Unadilla	G 18. F 20.94	4. 5.16	15. 10.27
4491	The Dewey Bros. Co., Blanchester, O. "Queen 3 D Grains" †	Binghamton	G 18. F 21.68	4. 5.46	15. 10.05
4469	Dock & Coal Co., Plattsburgh, N. Y. "Buttercup Feed"	Plattsburgh	G 29.80 F 30.44	9.80 10.41	14. 10.29
4557	Donahue-Stratton Co., Milwaukee, Wis. "Hiquality Spirits Distillers' Grains"	Bergen	G 30. F 33.63	10. 12.50	14. 13.69
4265	F. W. Goeke & Co., St. Louis, Mo. "Eddington Feed" †	Deposit	G 17. F 18.75	4.74 6.04	—— 9.67
3227	The Hottelet Co., Milwaukee, Wis. "Hector Distillers' Dried Grains"	Philadelphia	G 30. F 28.35	10. 11.49	14. 9.16
4075	The Hottelet Co., Milwaukee, Wis. "Hector Distillers' Dried Grains"	Canastota	G 30. F 28.81	10. 11.20	14. 8.70
4169	The Hottelet Co., Milwaukee, Wis. "Hector Distillers' Dried Grains"	Darien	G 30. F 30.44	10. 11.50	14. 8.70
3943	The Hottelet Co., Milwaukee, Wis. "National Distillers' Dried Grains"	Johnsonburg	G 23. F 25.38	6. 8.16	14. 11.43

* These letters indicate, respectively, Guaranteed and Found.
† Rye distillers' grains.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	DRIED DISTILLERS' GRAINS:				
4072	The Hottelet Co., Milwaukee, Wis., "National Distillers' Dried Grains"	Oneida	G* 23. F* 26.44	6. 8.65	14. 11.78
4380	The Hottelet Co., Milwaukee, Wis. "Pure Rye Grains"	Edmeston	G 16. F 14.63	8. 6.66	14. 14.47
4381	The Hottelet Co., Milwaukee, Wis. "Pure Rye Grains"	Edmeston	G 18. F 17.31	6. 8.17	14. 12.75
3216	Husted Milling Co., Buffalo, N. Y "Husted Distillers' Grains."	Potsdam	G 30. F 33.91	8. 13.49	11. 10.43
4142	Husted Milling Co., Buffalo, N. Y. "Husted Distillers' Grains"	N. Franklin	G 30. F 37.63	8. 11.90	11. 9.46
3946	Meadville Penn. Distilling Co., Inc., Meadville, Pa. "Distillers' Dried Grains"†	Johnsonburg	G 13.87 F 13.91	8.41 8.80	18.22 12.59
4081	Merchants Distilling Co., Terre Haute, Ind. "Merchants High Grade Dairy Feed"	Preble	G 30. F 31.13	11. 14.29	14. 9.87
4600	Merchants Distilling Co., Terre Haute, Ind. "Merchants High Grade Dairy Feed"	Randolph	G 30. F 31.06	11. 11.99	14. 8.79
3221	J. D. Page & Co., Inc., Syracuse, N. Y. "Empire State Dairy Feed"	Heuvelton	G 30. F 31.56	9. 12.87	12. 11.54
3939	Jay D. Page & Co., Inc., Syracuse, N. Y. "Empire State Dairy Feed"	Alexander	G 30. F 32.56	9. 12.25	12. 7.61
4104	Jay D. Page & Son, Syracuse, N. Y. "Mohawk Dairy Feed"	Altamont	G 24. F 27.13	8. 7.86	26. 9.49
4202	Jay D. Page & Co., Inc., Syracuse, N. Y. "Empire State Dairy Feed"	Granville	G 30. F 33.13	9. 13.76	12. 8.43

* These letters indicate, respectively, Guaranteed and Found.
† Rye distillers' grains.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	DRIED DISTILLERS' GRAINS:				
4426	J. D. Page & Son, Syracuse, N. Y. "Pure Empire State Dairy Feed"	Candor	G* 30. F* 31.81	12. 11.82	12. 9.23
4319	Purdy Brothers, Jamestown, N. Y. "Empire Flakes Pure Distillers' Grains"	Friendship	G 30. F 31.63	9. 13.74	12. 11.13
3848	Traders and Producers Supply Co., Buffalo, N. Y. "Seneca Distillers' Grains"	Jamestown	G 28. F 27.81	8. 11.79	14. 7.27
4448	Traders & Producers Supply Co., Buffalo, N. Y. "Chippewa Distillers' Grains"	Spencerport	G 30. F 31.25	10. 12.61	14. 11.06
4554	Traders & Producers Supply Co., Buffalo, N. Y. "Chippewa Distillers' Grains"	Batavia	G 30. F 31.63	10. 14.73	14. 11.39
4086	United American Co., Louisville, Ky. "U-A Corn Distillers' Aerated Grain"	Afton	G 28. F 27.56	9. 10.78	13. 5.03
4110	United American Co., Louisville, Ky. "U-A Corn Distillers' Aerated Grain"	Cobleskill	G 28. F 28.16	9. 9.92	13. 9.62
	DRIED BREWERS' GRAINS:				
4139	Anheuser-Busch Brewing Ass'n, St. Louis, Mo. "Dried Brewers' Grains"	Cooperstown	G 22. F 25.25	6. 7.32	17. 13.46
4020	Anheuser-Busch Brewing Ass'n, St. Louis, Mo. "Steam Dried Brewers' Grains"	Utica	G 22. F 25.88	6. 7.10	17. 13.33
4410	Anheuser-Busch Brewing Ass'n, St. Louis, Mo. "Steam Dried Brewers' Grains"	Chenango Bridge	G 22. F 26.	6. 5.41	16. 14.28
3977	Atlantic Export Co. of Wis., Chicago, Ill. "Dried Brewers' Grains"	Waverly	G 27. F 33.25	7. 6.37	13. 12.14
4209	Atlantic Export Co. of Wis., Chicago, Ill. "Dried Brewers' Grains"	Glens Falls	G 27. F 34.31	7. 7.56	13. 11.27

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	DRIED BREWERS' GRAINS:				
4021	M. F. Baringer, Philadelphia, Pa. "Dried Brewers' Grains"	Utica	G* 25. F* 32.94	6. 7.11	15. 11.94
4090	M. F. Baringer, Philadelphia, Pa. "Dried Brewers' Grains"	Groton	G 25. F 31.81	6. 6.81	15. 11.07
4241	Bartholomay Brewery Co., Rochester, N. Y. "Dried Brewers' Grains"	Middletown	G 20.03 F 21.13	6.40 6.08	21.03 16.81
4475	Bartholomay Brewery Co., Rochester, N. Y. "Dried Brewers' Grains"	Rochester	G 20.60 F 18.88	7.30 6.66	22.45 18.74
4368	Farmers Feed Co., New York, N. Y. "Bull-Brand Dried Brewers' Grains"	Pawling	G 27.20 F 29.25	6.30 7.46	17.20 12.23
3958	Francis Duhne, Jr., Milwaukee, Wis. "Tomahawk Brand Pure Dried Brewers' Grains"	Binghamton	G 26. F 29.63	6. 7.17	14. 10.57
4236	Francis Duhne, Jr., Milwaukee, Wis. "Tomahawk Brand Pure Dried Brewers' Grains"	Chester	G 26. F 24.31	6. 8.55	14. 12.02
4453	Francis Duhne, Jr., Milwaukee, Wis. "Tomahawk Brand Pure Dried Brewers' Grains"	Sauquoit	G 26. F 30.63	6. 7.	14. 12.26
4135	F. W. Goeke & Co., St. Louis, Mo. "Brewers' Dried Grains"	Cooperstown	G 24. F 36.25	7. 7.43	13. 8.62
3248	Hoffman & Co., Syracuse, N. Y. "Brewers' Dry Grains"	Phoenix	G 23. F 26.59	5.10 7.47	15. 11.24
3969	Hoffman & Co., Syracuse, N. Y. "Brewers' Dry Grains"	Sanitaria Springs	G 23. F 27.53	5.10 7.57	15. 12.43

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	DRIED BREWERS' GRAINS:				
4223	The Hottelet Co., Milwaukee, Wis. "Holstein Dried Brewers' Grains"	Chester	G* 25. F* 28.81	5. 7.56	17. 12.03
4427	Leisy Brewing Co., Peoria, Ill. "Pure Dried Brewers' Grains"	Binghamton	G —— F 26.56	—— 6.19	—— 13.89
4527	Milwaukee Grains & Feed Co., Milwaukee, Wis. "Crown Brewers' Dried Grains"	Port Chester	G 25. F 33.	5. 6.48	15. 12.22
4288	The Pennsylvania Central Brewing Co., Scranton, Pa. "Dried Brewers' Grain"	Conklin	G 23.71 F 23.94	7.14 6.94	15.85 14.07
4218	Rosekrans-Snyder Co., Philadelphia, Pa. "Pilsner Brewers' Dried Grains"	Goshen	G 25. F 32.81	5. 6.87	18. 12.39
4457	Rosekrans-Snyder Co., Philadelphia, Pa. "Pilsner Brewers' Dried Grains"	Clinton	G 25. F 31.75	5. 5.77	18. 11.81
4286	Jos. Schlitz Brewing Co., Milwaukee, Wis. "Schlitz Purity Dried Grains"	Binghamton	G 26. F 27.43	6. 6.74	14. 13.03
4353	Jos. Schlitz Brewing Co., Milwaukee, Wis. "Schlitz Purity Dried Grains"	Pine Bush	G 26. F 31.69	6. 5.93	14. 12.44
	GLUTEN FEEDS:				
3922	American Maize Products Co., New York, N. Y. "Cream of Corn Gluten Feed"†	South Alabama	G 23. F 25.63	2.50 3.17	8.50 5.61
3985	American Maize-Products Co., Roby, Ind. "Cream of Corn Gluten Feed"‡	Cortland	G 23. F 26.75	2.50 3.36	8.50 5.59
4103	American Maize-Products Co., New York, N. Y. "Cream of Corn Gluten Feed"§	Altamont	G 23. F 26.56	2.50 3.85	8.50 6.68

* These letters indicate, respectively, Guaranteed and Found.

† Manufacturers' guarantee: "Artificially colored with No. 85 Orange I, No. 4 Napthol Yellow S. Found, Artificially colored.

‡ Guaranteed artificially colored.

§ Guaranteed artificially colored with No. 85 Orange I, No. 4 Napthol Yellow. S.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	GLUTEN FEEDS:				
4007	Clinton Sugar Refining Co., Clinton, Ia. "Clinton Gluten Feed"	Rome	G* 20. F* 26.63	3. 3.85	7.50 6.49
4149	Clinton Sugar Refining Co., Clinton, Ia. "Clinton Gluten Feed"	Oneonta	G 20. F 26.13	3. 4.61	7.50 6.50
3234	Corn Products Refining Co., New York, N. Y. "Buffalo Gluten Feed"	Adams	G 23. F 23.22	2.5 3.89	8.5 5.82
3921	Corn Products Refining Co., New York, N. Y. "Buffalo Gluten Feed"	Corfu	G 23. F 26.13	2.50 2.16	8.50 5.02
3961	Corn Products Refining Co., New York, N. Y. "Buffalo Gluten Feed"	Greene	G 23. F 27.88	2.5 2.70	8.5 6.24
4289	Corn Products Refining Co., New York, N. Y. "Buffalo Gluten Feed"	Nichols	G 23. F 28.94	2.5 3.89	8.5 6.16
4105	Corn Products Refining Co., New York, N. Y. "Buffalo Gluten Feed" †	Central Bridge	G 24. F 26.97	2.5 2.61	8.5 6.28
4174	Corn Products Refining Co., New York, N. Y. "Crescent Gluten Feed"	Lockport	G 23. F 28.44	2.5 2.95	8.5 5.61
4079	Corn Products Refining Co., New York, N. Y. "Crescent Gluten Feed"	Tully	G 23. F 28.75	2.5 2.28	8.5 5.32
4119	Corn Products Refining Co., New York, N. Y. "Globe Gluten Feed"	Worcester	G 23. F 27.22	2.5 3.30	8.5 6.44
4354	Corn Products Refining Co., New York, N. Y. "Diamond Gluten Feed"	Ellenville	G 23. F 27.25	2.50 2.47	8.50 6.07
4423	Corn Products Refining Co., New York, N. Y. "Diamond Gluten Feed" ‡	Norwich	G 23. F 28.31	2.50 4.88	8.50 5.11

* These letters indicate, respectively, Guaranteed and Found.
† Guaranteed and found artificially colored.
‡ Contains corn cob.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	GLUTEN FEEDS:				
3918	Douglas & Co., Cedar Rapids, Ia. "Cedar Rapids Gluten Feed"	Corfu	G* 20. F* 21.	3. 3.44	8. 6.25
4073	Douglas & Co., Cedar Rapids, Ia. "Cedar Rapids Gluten Feed"	Oneida	G 22. F 17.31	4. 2.71	8. 5.03
3235	J. C. Hubinger Bros. Co., Keokuk, Ia. "K K K Gluten Feed"	Adams	G 23.50 F 23.10	2.50 4.35	7.80 6.10
3919	J. C. Hubinger Bros. Co., Keokuk, Ia. "K K K Gluten Feed"	Corfu	G 23.50 F 24.22	3.25 3.58	7.50 5.64
4068	J. C. Hubinger Bros. Co., Keokuk, Ia. "K K K Gluten Feed"	Norwich	G 23.50 F 24.56	3.25 4.95	7.50 6.19
4114	J. C. Hubinger Bros. Co., Keokuk, Ia. "K K K Gluten Feed"	East Worcester	G 23.50 F 24.63	3.25 4.92	7.50 5.82
4183	J. C. Hubinger Bros. Co., Keokuk, Ia. "K K K Gluten Feed"†	Geneseo	G 23. F 24.56	2. 4.40	7.50 6.51
4235	Huron Milling Co., Harbor Beach, Mich. "Jenks' Gluten Feed"‡	Monroe	G 23. F 23.94	3. 4.70	8. 6.16
3920	Piel Bros. Starch Co., Indianapolis, Ind. "P Bro. Gluten Feed" §	Corfu	G 21. F 23.07	2. 3.01	8. 5.59
4216	Piel Bros. Starch Co., Indianapolis, Ind. "P Bro. Gluten Feed"§	Montgomery	G 21. F 23.37	2. 3.06	8. 4.52
4222	Union Starch & Refining Co., Edinburg, Ind. "Union Gluten Feed"	Warwick	G 24. F 25.88	3. 3.38	6.30 7.06

* These letters indicate, respectively, Guaranteed and Found.
† Guaranteed artificially colored with aniline.
‡ Guaranteed artificially colored with No. 4 Napthol Yellow S., No. 85 Orange.
§ Guaranteed occasionally colored with orange No. 122.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	GLUTEN MEALS:				
3846	Corn Products Refining Co., New York "Diamond Gluten Meal"	Salamanca	G* 40. F* 46.75	1.5 1.62	4. .79
4003	Corn Products Refining Co., New York, N. Y. "Diamond Gluten Meal"	Fulton	G 40. F 39.38	1.50 3.04	4. 1.36
	HOMINY FEEDS:				
3962	American Hominy Co., Indianapolis, Ind. "Homco Feed"	Greene	G 9.50 F 10.69	7. 7.24	7. 4.79
4213	American Hominy Co., Indianapolis, Ind. "Maizeline Feed"	New Paltz	G 7. F 9.25	4. 7.91	13. 6.46
4221	American Hominy Co., Indianapolis, Ind. "Homco Feed"	Goshen	G 9.5 F 11.50	7. 7.99	7. 4.50
3239	M. F. Baringer Philadelphia, Pa. "Hominy Feed"	Watertown	G 9. F 10.82	6. 9.58	10. 4.66
4109	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Hominy Feed"	Cobleskill	G 10. F 10.72	7. 8.47	4. 3.40
4290	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Hominy Feed"	Nichols	G 10. F 10.75	7. 7.63	4. 3.63
3982	East Waverly Milling Co., Waverly, N. Y. "Hominy Feed"	Waverly	G 11.55 F 9.94	7.68 7.09	4.11 3.45
3993	Elevator Milling Co., Springfield, Ill. "Ideal Hominy Feed Kiln Dried"	Ithaca	G 11.02 F 11.10	7.70 9.93	—— 4.15
4070	Empire Grain & Elevator Co., Binghamton, N. Y. "Pearl Hominy"	Norwich	G 10. F 11.	7. 7.79	6. 3.45
4233	Empire Grain & Elevator Co., Binghamton, N. Y. "Pearl Hominy"	Monroe	G 10. F 10.88	7. 4.99	6. 2.28

* These letters indicate, respectively, Guaranteed and Found.

Analyses of Samples of Feeding Stuffs — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	Hominy Feeds:				
3828	Evans Milling Co., Indianapolis, Ind. "Evans Hominy Feed"	Randolph	G* 10. F* 10.81	7.50 9.71	7. 3.41
3917	Evans Milling Co., Indianapolis, Ind. "Evans Hominy Feed"	Corfu	G 10. F 10.78	7.50 9.	7. 4.33
3987	Evans Milling Co., Indianapolis, Ind. "Evans Hominy Feed"	Cortland	G 10. F 10.63	7.50 8.37	7. 4.34
4268	Charles Herendeen Milling Co., Chicago, Ill. "Herendeen's Hominy Feed"	Oxford	G 10.15 F 10.88	6.40 8.14	3.55 3.84
4323	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Capital Pure Kiln Dried Hominy Feed"	Cuba	G 11.02 F 9.13	7.78 6.38	——— 3.99
4145	Husted Milling Co., Buffalo, N. Y. "Yellow Hominy Feed"	North Franklin	G 9. F 9.94	6. 7.12	8. 3.56
4571	Husted Milling Co., Buffalo, N. Y. "Yellow Hominy Feed"	Buffalo	G 9. F 10.44	6. 7.28	8. 3.39
4201	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Hominy Feed"	Salem	G 9. F 12.44	7. 7.43	4.5 2.99
4238	Miner-Hillard Milling Co., Wilkes Barre, Pa. "Choice Steam Cooked Hominy Feed"	Sugar Loaf	G 10. F 11.06	7.50 10.17	5. 4.27
3931	A. Nowak & Son, Buffalo, N. Y. "Buffalo Hominy Feed"	Clarence	G 8. F 10.57	6. 8.29	8. 4.30
3953	The Patent Cereals Co., Geneva, N. Y. "Hominy Feed"	Binghamton	G 10. F 10.50	7. 7.06	5. 3.88
4107	The Patent Cereals Co., Geneva, N. Y. "Hominy Feed"	Central Bridge	G 10. F 11.31	7. 7.87	5. 3.15

*These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	HOMINY FEEDS:				
4282	The Patent Cereals Co., Geneva, N. Y. "Hominy Feed"	Valley Mills	G* 10. F* 10.94	7. 8.03	5. 3.53
4371	Wm. H. Payne & Son, New York, N. Y. "Hominy Chop"	Brewster	G 11.49 F 11.06	8. 7.59	—— 3.59
4365	Suffern, Hunt & Co., Decatur, Ill. "Acme Hominy Feed"	Chatham	G 9.30 F 11.	7.10 8.70	10. 4.35
4219	Thompson & Mould, Goshen, N. Y. "Matchless Corn Bran"†	Goshen	G 10.7 F 10.63	7.8 8.56	3.44 3.66
4229	Thompson & Mould, Goshen, N. Y. "Special Hominy Meal"	Monroe	G 10. F 10.31	7. 8.98	4.75 4.
3981	U. S. Frumentum Co., Detroit, Mich. "Frumentum Hominy Feed"	Waverly	G 9.50 F 10.76	7.30 8.94	7. 4.53

* These letters indicate, respectively, Guaranteed and Found.
† Hominy feed.

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
				Per ct.	Per ct.	Per ct.	
	Compounded Feeds:						
4331	Acme Milling Co., Olean, N. Y. " Acme Feed "	Olean	G*	7.	3.	9.	Corn, hominy and oat hulls.
			F*	9.31	4.39	6.25	Corn, hominy feed, oat hulls.
4389	Acme Milling Co., Olean, N. Y. " Acme Feed "	Albany	G	7.	3.	9.	Corn, hominy and oat hulls.
			F	8.50	3.72	7.08	As certified.
3820	J. & T. Adikes, Jamaica, N. Y " Ground Feed "	Jamaica	G	8.75	3.	6.	Barley, corn and corn and cob, oats and oat hulls.
			F	10.31	2.86	5.58	Corn, corn offal, oats, light oats, oat hulls, weed seeds partly ground.
3925	Akron Produce Co., Akron, N. Y. " Bower's Dairy Ration "	Akron	G	24.	6.	8.50	Gluten, distillers' grains, hominy, oil meal, cottonseed meal, wheat bran, wheat middlings, salt.
			F	28.75	6.53	7.52	As certified.
4047	The Albert Dickinson Co., Chicago, Ill. " White Cross Stock Feed "	Amsterdam	G	10.	3.50	10.	Corn, oats, barley, wheat meal, salt one-half of one per cent.
			F	8.91	3.73	3.91	Corn, kaffir corn, oats, light oats, light barley, small, granular particles of wheat, salt.
4140	The Albert Dickinson Co., Chicago, Ill. " White Cross Stock Feed "	Oneonta	G	10.	3.5	10.	Corn, oats, barley, wheat meal, salt.
			F	10.31	4.56	4.61	Corn, oats, light oats, kaffir corn, light barley, small granular particles of wheat, salt.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4407	Andrews, Son & Co., Penn Yan, N. Y. "No. 2 Chop Feed"	Penn Yan	G* 11.50	4.25	8.	Corn oats and bran ⅓ each.
			F* 11.63	4.23	4.28	Corn, oats, wheat bran.
3971	Geo. W. Barton, Union, N. Y. "Our Mixed Feed"	Union	G ——	——	——	Oats, corn and wheat feed.
			F 11.97	4.53	5.22	Oats, corn, wheat bran, wheat middlings.
4422	The Beck Cereal Co., Detroit, Mich. "Royal Chop Feed"	Rochester	G 8.31	5.10	5.81	Ground corn, oat middlings, oat shorts and oat hulls.
			F 8.31	4.69	7.26	Corn, oat middlings, oat hulls, salt.
4464	The Beck Cereal Co., Detroit, Mich. "Royal Chop Feed"	Saranac Lake	G 10.	7.	9.	Made from corn, oat middlings, shorts and oat hulls.
			F 8.38	5.16	4.30	Corn, corn offal, oat middlings, oat hulls, salt.
3224	The J. W. Biles Co., Cincinnati, O. "Union grains Ubiko Biles Ready Dairy Ration'	Ogdensburg	G 24.	7.	9.	Fourex distillers' dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, barley malt sprouts, a small per cent of fine table salt, and nothing else.
			F 25.41	7.89	8.40	As certified.
3935	The J. W. Biles Co., Cincinnati, O. "Ubiko Horse and Stock Feed"	Akron	G 16.	6.	9.	Wheat middlings, hominy meal, wheat bran, brewers' dried grains, old process linseed meal and nothing else.
			F 19.22	7.31	6.97	Wheat, wheat bran, brewers' grains, corn, linseed meal.

3973	The J. W. Biles Co., Cincinnati, O., "Union Grains Ubiko Biles Ready Dairy Ration"	Owego	G	24.	7.	9.	Fourex distillers' dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, brewers' dried grains, barley malt sprouts, a small per cent of fine table salt and nothing else.
			F	25.78	7.60	8.06	As certified.
4128	The J. W. Biles Co., Cincinnati, O. "Union Grains Ubiko Biles Ready Dairy Ration"	Oneonta	G	24.	7.	9.	Fourex distillers' dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, barley malt sprouts, salt.
			F	24.09	7.32	7.25	As certified.
4152	The J. W. Biles Co., Cincinnati, O. "Union Grains Ubiko Biles Ready Dairy Ration"	Bliss	G	24.	7.	9.	Fourex distillers' dried grains, choice cottonseed meal, old process linseed meal, white wheat middlings, winter wheat bran, hominy meal, barley malt sprouts, small per cent fine salt.
			F	24.56	7.80	7.10	As certified.
4474	The J. W. Biles Co., Cincinnati, O. "Ubiko Horse and Stock Feed"	St. Johnsville	G	16.	6.	9.	Composed entirely of carefully cleaned wheat, corn, malted barley and linseed.
			F	18.81	7.24	7.57	Wheat, wheat bran, corn, brewers' grains, linseed meal.
4476	The J. W. Biles Co., Cincinnati, O. "Ubiko Horse and Stock Feed"	Webster	G	16.	6.	9.	Wheat middlings, hominy meal, wheat bran, brewers' dried grains, old process linseed meal, and nothing else.
			F	18.75	7.49	7.96	Wheat, wheat bran, corn, brewers' grains, linseed meal.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4406	The Birkett Mills, Penn Yan, N. Y. "Buckwheat Screenings"	Penn Yan	G* 10.	3.	15.	
			F* 10.88	2.22	9.81	Corn, buckwheat chaff, buckwheat hulls, screenings containing weed seeds partly ground, ground corn cob, sand.
3933	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Calf Meal"	Akron	G 25.	5.	5.	Locust bean meal, wheat flour, flaxseed, cottonseed meal, beans and lentils.
			F 24.13	4.84	5.43	Locust bean meal, wheat flour, flaxseed, cottonseed meal, bean meal, lentils, fenugreek, ground cocoa shells.
3954	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Calf Meal"	Binghamton	G 25.	5.	5.	Locust bean meal, wheat flour, flaxseed, cottonseed meal, beans and lentils.
			F 23.69	4.45	5.56	Locust bean meal, wheat flour, flaxseed, cottonseed meal, bean meal, lentils, fenugreek, ground cocoa shells.
4031	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Calf Meal"	Parish	G 25.	5.	5.	Locust bean meal, wheat flour, flaxseed, cottonseed meal, beans and lentils.
			F 24.88	5.67	5.78	Locust bean meal, wheat flour, flaxseed, cottonseed meal, bean meal, lentils, fenugreek, ground cocoa shells.
4125	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Calf Meal"	Oneonta	G 25.	5.	5.	Locust bean meal, wheat flour, flaxseed, cottonseed meal, beans and lentils.
			F 23.94	5.25	4.74	Locust bean meal, wheat flour, flaxseed, cottonseed meal, bean meal, lentils, fenugreek, ground cocoa shells.

3816	S. W. Bowne Co., Brooklyn, N. Y. "Ground Feed"	Brooklyn	G	7.	3.	11.	Corn, hominy chops, oat hulls.
			F	9.81	4.41	3.60	As certified.
3812	John D. Braue, New York, N. Y. "Braue's Mixed Feed"	New York	G	12.	4.	12.	A mixture of crushed oats, cracked corn and alfalfa meal.
			F	12.	3.83	6.63	As certified.
3815	Brooklyn Elevator & Milling Co., Brooklyn, N. Y. "Bemco Stock Feed"	Brooklyn	G	9.	3.	8.	Corn, oats, barley and bran.
			F	9.94	3.99	3.59	Corn, corn bran, corn offal, oats, light oats, oat hulls.
4044	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Horse Feed"	Utica	G	10.	4.	8.	Made from oats, corn, barley, gluten feed, wheat middlings, hominy feed, ground oats, oat hulls, oat bran, oat middlings.
			F	11.75	4.43	7.79	As certified.
4123	Buffalo Cereal Co. Buffalo, N. Y. "Bufceco Horse Feed"	Oneonta	G	10.	4.	8.	Oats, corn, barley, gluten feed, wheat middlings, hominy feed, ground oats, oat hulls, oat bran, oat middlings.
			F	12.13	4.59	7.69	Oats, corn, barley, gluten feed, wheat middlings, hominy feed, linseed meal, oat middlings, oat hulls.
4430	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Horse Feed"	Syracuse	G	10.	4.	8.	Oats, corn, barley, gluten feed, wheat middlings, hominy feed, ground oats, oat hulls, oat bran, oat middlings.
			F	12.31	4.61	7.41	Corn, oats, barley, gluten feed, wheat middlings, hominy feed, oat middlings, oat hulls.
4560	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Horse Feed"	Buffalo	G	10.	4.	8.	Oats, corn, barley, gluten feed, wheat middlings, hominy feed, ground oats, oat hulls, oat bran, oat middlings.
			F	12.75	4.88	8.48	Oats, corn, barley, hominy feed, gluten feed, wheat middlings, linseed meal, oat middlings, oat hulls.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
3974	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Stock Feed"	Owego	G* 8. F* 9.69	4. 4.85	9. 7.83	Corn, hominy feed, oat hulls, oat bran, gluten feed. As certified.
4108	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Stock Feed"	Cobleskill	G 8. F 9.25	4. 5.28	9. 7.18	Corn, hominy feed, oat hulls, oat bran, gluten feed. As certified.
4194	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Stock Feed"	Williamsville	G 8. F 8.94	4. 4.37	9. 7.32	Corn, hominy feed, oat hulls, oat bran, gluten feed. As certified.
4043	Buffalo Cereal Co., Buffalo, N. Y. "Chop Feed"	Clinton	G 7. F 9.06	3. 4.33	9. 9.71	Made from corn, hominy feed, oat bran, oat hulls. As certified.
4160	Buffalo Cereal Co., Buffalo, N. Y. "Chop Feed"	Alden	G 7. F 9.19	3. 3.73	9. 8.83	Corn, hominy feed, oat bran, oat hulls. As certified.
4195	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Chop Feed"	Buffalo	G 7. F 8.75	3. 3.95	9. 10.22	Corn, hominy feed, oat bran, oat hulls. As certified.
4246	Buffalo Cereal Co., Buffalo, N. Y. "Chop Feed"	West Town	G 7. F 9.13	3. 3.94	9. 10.31	Corn, hominy feed, oat bran, oat hulls. As certified.

4413	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Chop Feed"	Syracuse	G	7.	3.	9.	Corn, hominy feed, oat bran, oat hulls.
			F	9.06	4.13	10.55	As certified.
4193	Buffalo Cereal Co., Buffalo, N. Y. "Dairy Feed"	Williamsville	G	12.	3.	8.	Corn, wheat middlings, hominy feed, gluten feed, oat hulls.
			F	13.56	4.13	9.02	Corn, oat middlings, oat hulls, wheat bran, gluten feed, linseed meal, hominy feed.
4414	Buffalo Cereal Co., Buffalo, N. Y. "Creamery Feed"	Syracuse	G	18.	4.	8.	Corn, wheat middlings, oat hulls, hominy feed, cottonseed meal, gluten feed.
			F	20.06	4.75	9.21	As certified.
4535	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Creamery Feed"	White Plains	G	18.	4.	8.	Corn, wheat middlings, hominy feed, cottonseed meal, gluten feed, oat hulls.
			F	21.06	5.95	8.69	As certified.
4561	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Creamery Feed"	Buffalo	G	18.	4.	8.	Corn, wheat middlings, hominy feed, cottonseed meal, gluten feed, oat hulls.
			F	20.19	5.04	9.63	Corn, wheat bran, wheat middlings, hominy feed, cottonseed meal, gluten feed, oat hulls.
4511	Cairnsmuir Farm, New City, N. Y. "Cairnsmuir Horse Feed"	New City	G	12.	5.	5.50	Wheat middlings, ground rye, red dog flour, wheat bran, corn meal, crushed oats.
			F	14.31	4.78	5.	As certified.
4512	Cairnsmuir Farm, New City, N. Y. "Cairnsmuir Cow Feed"	New City	G	16.	5.	15.50	Buckwheat middlings, wheat middlings, wheat bran, corn meal, cottonseed meal.
			F	18.75	5.	12.87	Buckwheat middlings, buckwheat hulls, wheat bran, wheat middlings, corn meal, cottonseed meal.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
3223	Chapin & Co., Buffalo, N. Y. "Unicorn Dairy Ration"	Rensselaer Falls	G* 26.	5.5	10.	Distillers' feed, green diamond cottonseed meal, green diamond hominy, corn, gluten feed, barley feed, sprouts, brewers' grains and pure wheat bran.
			F* 25.63	8.02	8.01	As certified.
3959	Chapin & Co., Buffalo, N. Y. "Unicorn Dairy Ration"	Greene	G 26.	5.5	10.	Distillers' feed, green diamond cottonseed meal, green diamond hominy, corn, gluten feed, barley feed, sprouts, brewers' grains and pure wheat bran.
			F 26.50	6.80	8.05	As certified.
4131	Chapin & Co., Milwaukee, Wis. "Unicorn Dairy Ration"	Oneonta	G 26.	5.5	10.	Distillers' feed, green diamond cottonseed meal, green diamond hominy, wheat or corn gluten feed, barley feed and sprouts, pure wheat bran.
			F 26.56	6.33	8.22	As certified.
4157	Chapin & Co., Hammond, Ind. "Unicorn Dairy Ration"	Warsaw	G 26.	5.5	10.	Distillers' feed, green diamond cottonseed meal, green diamond hominy, wheat and corn gluten feed, barley feed and sprouts, pure wheat bran. Warranted free from salt, molasses, screenings or weed seeds.
			F 27.19	5.35	6.06	As certified.
3245	Chesbro Milling Co., Salamanca, N. Y. "Chesbro's Stock Feed"	New Haven	G 10.	3.25	9.	Corn, barley, cottonseed meal, oat shorts, oat middlings, oat hulls, one-half of one per cent salt.
			F 10.10	4.18	6.	As certified.

3941	Chesbro Bros., Attica, N. Y. "Mix Feed 'E'"	Attica	G	23.	6.	10.	Empire State Dairy Feed consisting of distillers' dried grains, cottonseed meal, bran, middlings, corn meal.
			F	28.97	8.62	8.06	Distillers' grains, cottonseed meal, linseed meal, corn, wheat bran, gluten feed.
3950	Chesbro Milling Co., Salamanca, N. Y. "Chesbro's Stock Feed"	Arcade	G	10.	3.25	9.	Corn, barley, cottonseed meal, oat shorts, oat middlings, oat hulls, one-half of one per cent salt.
			F	10.26	4.36	6.06	Corn meal, barley, cottonseed meal, oat middlings, oat hulls, salt.
4481	Chesbro Milling Co., Salamanca, N. Y. "Chesbro's Stock Feed"	Weedsport	G	10.	3.25	9.	Corn, barley, cottonseed meal, oat shorts, oat middlings, oat hulls, one-half of one per cent salt.
			F	8.63	3.05	7.	Corn, barley, cottonseed meal, oat middlings, oat hulls.
4480	Chesbro Milling Co., Salamanca, N. Y. "Peerless Dairy Feed"	Weedsport	G	24.	7.	9.	Brewers' grains, cottonseed meal, oil meal, bran, middlings, malt sprouts, hominy.
			F	24.37	6.80	6.65	Brewers' grains, cottonseed meal, linseed meal, wheat bran, wheat middlings, malt sprouts, hominy feed, corn, distillers' grains.
4585	Chesbro Milling Co., Salamanca, N. Y. "Peerless Dairy Feed"	Avon	G	24.	7.	9.	Brewers' grains, cottonseed meal, oil meal, bran, middlings, malt sprouts, hominy.
			F	25.19	6.96	5.50	Brewers' grains, cottonseed meal, linseed meal, wheat bran, wheat middlings, malt sprouts, hominy feed, corn, distillers' grains.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4153	Chesbro Milling Co., Salamanca, N. Y. "Trojan Feed"	Silver Springs	G* 7.	3.	12.	Corn, barley, oat shorts, oat middlings and oat hulls and one-half of one per cent salt.
			F* 9.13	4.06	5.30	Corn, barley, oat middlings, oat hulls, salt.
4435	Chesbro Milling Co., Salamanca, N. Y. "Trojan Feed"	Bath	G 7.	3.	12.	Corn, barley, oat shorts, oat middlings and oat hulls, one-half of one per cent salt.
			F 9.13	3.37	6.30	Corn, barley, oat middlings, oat hulls, salt.
4180	The Cleveland Seed Co., Avon, N. Y. "Pea Shucks and Broken Pieces of Peas"	Avon	G 20.	1.20	18.	
			F 20.69	1.51	19.52	As branded.
4466	Clinton Milling & Grain Co., Plattsburgh, N. Y. "Derby Feed"	Plattsburgh	G 7.50	2.95	11.24	Corn, oats, ground corn cob, oat hulls.
			F 9.44	3.40	9.28	Corn, oats, oat hulls, corn bran.
3220	Commercial Milling Co., Detroit, Mich. "Henkels Coarse Brown Feed"	Winthrop	G 15.	4.	8.	From wheat and buckwheat middlings, white corn and rye middlings.
			F 16.72	5.44	6.41	As certified.

4547	W. H. Coonrod Co., Port Jervis, N. Y. " Horse Feed "	Port Jervis	G	9.50	5.02	4.49	Corn, ground oats, wheat and rye middlings, oat meal mill by-products (oat hulls and oat middlings), hominy, wheat flour, one-half of one per cent salt.
			F	9.88	4.57	8.91	Corn, ground oats, wheat middlings, rye middlings, oat hulls, oat middlings, hominy feed, wheat flour, ground corn cobs, salt.
4032	Corn Products Refining Co., New York, N. Y. " Diamond Hog Meal "	Central Square	G	[illegible]	8.	13.	
			F	1[illegible].38	11.43	10.63	Ground corn oil cake, charred bone.
4326	Corn Products Refining Co., New York, N. Y. " Diamond Hog Meal "	Cuba	G	18.	8.	13.	
			F	21.06	12.95	8.09	Ground corn oil cake, charred bone.
4602	Crow & Williams, Ossining, N. Y. " Mixed Feed "	Ossining	G	8.	3.	12.	Corn, hominy, wheat bran, light oats, wheat middlings.
			F	10.06	4.16	6.62	As certified.
4465	Dock & Coal Co., Plattsburgh, N. Y. " Dandy Feed "	West Chazy	G	8.	5.	8.	Corn meal, wheat and oat middlings, *oats and oat hulls.*
			F	8.81	5.11	5.21	Corn, corn offal, wheat middlings, oats, oat middlings, oat hulls.
4066	R. D. Eaton Grain & Feed Co., Norwich, N. Y. " Special Dairy Feed "	Norwich	G	10.	3.	12.	Alfalfa meal, oil meal, pea meal, brewers' grains, corn, oats and barley.
			F	12.75	4.20	8.99	Corn meal, corn offal, alfalfa meal, pea meal, oil meal, refuse from barley and oats, buckwheat hulls.

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ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
4392	Elmore Milling Co., Oneonta, N. Y. "Corn and Oat Provender"	Stuyvesant Falls	G* 8.75	3.50	9.	Corn, ground oats, oat hulls, corn bran, and salt.
			F* 9.69	3.03	5.14	Corn, corn offal, hominy feed, oat middlings, light oats, oat hulls, small amount of wheat, barley, screenings, salt.
4146	Elmore Milling Co., Oneonta, N. Y. "Susquehanna Stock Feed"	Oneonta	G 7.76	3.63	——	Oats, corn meal, corn bran.
			F 8.88	3.46	6.95	Corn, oats, oat hulls, salt.
4078	Empire Grain & Elevator Co., Binghamton, N. Y. "Neverfail Dairy Feed"	Tully	G 25.	6.	9.	Cottonseed meal, distillers' grains, linseed meal, gluten meal, brewers' grains, corn meal, barley, malt sprouts, wheat bran, salt not to exceed three-fourths of one per cent.
			F 24.50	5.85	6.90	As certified.
4336	The Empire Mfg. Co., Franklinville, N. Y. "Empire Stock Feed"	Franklinville	G 20.	3.	8.	Malt sprouts, wheat bran, corn, cottonseed meal, gluten, oil meal, distillers' grains.
			F 24.13	3.89	8.30	As certified.
4332	Empire Mills, Olean, N. Y. "Empire Feed"	Olean	G 7.50	3.	9.	Corn, hominy, oat hulls.
			F 8.63	3.96	6.21	As certified.

4486	Empire Mills, Olean, N. Y. "Empire Feed"	Auburn	G	7.50	3.	9.	Corn, hominy, oat hulls.
			F	9.	3.43	6.35	As certified.
4502	Empire Mills, Olean, N. Y. "Empire Feed"	Salisbury Mills	G	7.50	3.	9.	Corn, hominy, oat hulls.
			F	9.25	3.97	5.61	As certified.
4609	Empire Mill & Coal Co., Schaghticoke, N. Y. "Corn and Oat Feed"	Schaghticoke	G	——	——	——	Corn, oats and bran, some sweepings.
			F	10.94	2.85	3.56	As certified.
4608	Empire Mill & Coal Co., Schaghticoke, N. Y. "Empire Milk Producer"	Schaghticoke	G	——	——	——	Malt sprouts, beet pulp, rye middlings, corn meal, cottonseed meal, one per cent salt.
			F	17.13	3.13	7.85	As certified.
4397	Everett & Treadwell Co., Kingston, N. Y. "C. O. & W. Feed"	Kingston	G	11.50	3.50	——	Ground corn, ground oats, wheat middlings.
			F	13.13	4.01	3.39	As certified.
4250	C. J. Everson, Middletown, N. Y. "Horse Feed"	Middletown	G	8.	3.	7.	Corn meal, ground oats, wheat middlings, wheat bran, hominy meal, linseed oil meal and salt.
			F	12.69	4.12	3.63	As certified.
4009	General Flour & Feed Co., Buffalo, N. Y. "Big 4 Chop Feed"	Camden	G	7.	3.	12.	Cracked corn, corn and cob meal, ground oat hulls, oat middlings, corn bran.
			F	9.51	4.97	12.96	As certified.
4051	General Flour & Feed Co., Buffalo, N. Y. "Honest Cow Feed"	Syracuse	G	24.	6.	9.	Distillers' grains, gluten, wheat middlings, corn meal, wheat bran, one and one-quarter per cent salt, corn bran, cottonseed meal, and oil meal.
			F	24.50	8.13	7.25	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4551	General Flour & Feed Co. Buffalo, N. Y. "Honest Cow Feed'	Buffalo	G 24.	6.	9.	Distillers' grains, gluten, wheat middlings, corn meal, wheat bran, one and one-quarter per cent salt, corn bran, cottonseed meal, and oil meal.
			F 25.13	8.35	8.51	As certified.
4095	General Flour & Feed Co. Buffalo, N. Y. "Standard M & S"	Syracuse	G 10.	3.	10.	Wheat bran, B meal, which is composed of corn and cob meal, the amount of cob used being the same as though ear corn was ground cob and all.
			F 12.75	4.29	5.28	As certified.
4033	Gilbert & Nichols Co., Fulton, N. Y. "Fulton Dairy Feed"	Fulton	G 26.	6.	9.	Distillers' grains, malt sprouts, brewers' grains, cottonseed meal, buckwheat middlings, gluten feed, wheat bran, corn meal mixed with a very small quantity of salt.
			F 31.13	6.74	7.09	Distillers' grains, malt sprouts, brewers' grains, cottonseed meal, buckwheat middlings, buckwheat hulls, gluten feed, wheat bran, corn meal, salt.
4285	Gilbert & Nichols Co., Fulton, N. Y. "Fulton Dairy Feed"	Syracuse	G 26.	6.	9.	Distillers' grains, malt sprouts, brewers' grains, cottonseed meal, old process oil meal, buckwheat middlings, gluten feed, wheat bran, corn meal and salt.
			F 29.25	6.13	8.46	Distillers' grains, malt sprouts, brewers' grains, cottonseed meal, linseed meal, buckwheat middlings, buckwheat hulls, gluten feed, wheat bran, corn meal, salt.

4350	Geo. H. Gisel & Co., Buffalo, N. Y. "Stone Mills Mixed Feed"	Buffalo	G	10.	2.	17.	Winter wheat bran, winter wheat middlings, low grade flour, ground corn.
			F	15.37	5.88	7.46	Corn, wheat bran, wheat middlings, low grade flour, weed seeds partly ground.
4025	Globe Elevator Co., Buffalo, N. Y. "C. O. & B. Chop Feed"	Malone	G	6.	3.	17.	Corn, oats, oat hulls, hominy feed, barley screenings, cob meal, middlings and about 5 pounds salt to the ton.
			F	8.06	3.44	8.54	As certified.
4449	Globe Elevator Co., Buffalo, N. Y. "International Stock Food"	Spencerport	G	30.	4.	8.	Old process oil meal and ground seeds screened from flax and other grains.
			F	32.19	6.10	8.42	Linseed meal and screenings.
4166	Globe Elevator Co., Buffalo, N. Y. "No. 1 Chop Feed"	Alden	G	7.	3.	10.	Hominy feed, red dog flour, ground corn and cob, oats and oat hulls and about 5 pounds salt to the ton.
			F	10.13	4.37	7.22	As certified.
4053	General Flour & Feed Co., Buffalo, N. Y. "Big 4 Chop Feed"	Syracuse	G	7.	3.	12.	Cracked corn, corn and cob meal, ground oat hulls, oat middlings, corn bran.
			F	9.	4.66	11.51	As certified.
4552	General Flour & Feed Co., Buffalo, N. Y. "Big 4 Chop Feed"	Buffalo	G	7.	3.	12.	Cracked corn, corn and cob meal, ground oat hulls, oat middlings, corn bran.
			F	9.88	6.04	11.31	As certified.
4473	Globe Elevator Co., Buffalo, N. Y. "No. 1 Chop Feed"	St. Johnsville	G	7.	3.	10.	Made from hominy feed, red dog flour, ground corn and cob, oats and oat hulls and about 5 pounds salt to the ton.
			F	8.44	3.80	8.99	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
				Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:						
4163	Globe Elevator Co., Buffalo, N. Y. "Stone Mills Horse Feed"	Alden	G*	8.	4.	9.	Hominy feed, flour middlings, ground corn and cob, oats and oat hulls and about 5 pounds of salt to the ton.
			F*	8.56	3.77	6.56	Hominy feed, wheat middlings, ground corn and cob, oats, oat hulls, salt.
4303	J. Gorman, Buffalo, N. Y. "Boat Sweepings"	Buffalo	G	5.	2.	14.	Sweepings from boats loaded with flour and feed and consists of several materials having feeding stuffs value but it is impossible to name each ingredient.
			F	22.81	3.52	4.12	Wheat bran, wheat middlings, wheat flour, gluten feed, wheat, corn, flax-seed.
3944	D. H. Grandin, Jamestown, N. Y. "Eagle Feed"	Johnsonburg	G	8.	4.15	8.20	Corn, oats, oat hulls, corn bran.
			F	9.25	3.78	7.43	Corn, corn bran, oats, oat hulls, barley skimmings.
3947	D. H. Grandin Milling Co., Jamestown, N. Y. "Grandin's Stock Food"	North Java	G	10.	4.4	8.21	Oats, corn, barley, barley middlings, oat hulls and salt.
			F	9.25	3.47	5.53	As certified.
4339	James H. Gray Milling Co., Springville, N. Y. "Corn, Oats and Barley Chop Feed"	Springville	G	7.	4.	14.	Corn, oat hulls, hominy and barley.
			F	9.38	3.90	10.96	Corn, corn chaff, oat hulls, hominy feed, barley, small amount buckwheat hulls.

4133	The Great Western Cereal Co., Chicago, Ill. " Gregson's Calf Meal "	Oneonta	G	25.	5.	5.	Salt, oat meal, barley, linseed and cottonseed.
			F	27.63	7.17	4.03	As certified.
4444	The Great Western Cereal Co., Chicago, Ill. " Gregson's Calf Meal "	De Ruyter	G	25.	5.	5.	Maximum salt three-quarters of one per centum. Made from oat meal, barley, linseed and cottonseed.
			F	25.88	6.51	3.91	Oat meal, barley, linseed meal, cottonseed meal, fenugreek, salt.
4460	The Great Western Cereal Co., Chicago, Ill. " Gregson's Calf Meal "	Ilion	G	25.	5.	5.	Maximum salt three-quarters of one per centum. Made from oat meal, barley, linseed and cottonseed.
			F	24.43	6.56	4.28	As certified.
4400	The Great Western Cereal Co., Chicago, Ill. " Maizefalfa Feed "	Rondout	G	10.	4.	11.	Cracked corn, hominy feed, oat middlings and alfalfa meal.
			F	10.94	2.94	12.34	Cracked corn, hominy feed, oat middlings, alfalfa meal, salt.
4356	W. H. Haskell & Co., Toledo, O. " Haskell's Stock Feed "	Kelley Corners	G	8.	4.	8.	Corn, oats, hominy feed, oat hulls and oat shorts.
			F	10.44	7.40	5.59	As certified.
4262	Estate of S. T. Hayt, Corning, N. Y. " Algood Chop Feed "	Corning	G	8.	3.	8.	Corn, oats, bran, middlings, oat hulls and oat middlings.
			F	10.56	4.44	3.51	Corn, oats, wheat bran, wheat middlings, oat hulls, oat middlings, corn offal, buckwheat hulls.
4559	Henry & Missert, Buffalo, N. Y. " B. S. Stock Food "	Buffalo	G	13.	3.	10.50	Flour, bran and middlings from wheat, malt sprouts, gluten feed, flaxseed and wheat screenings.
			F	17.75	4.37	8.42	Wheat flour, wheat bran, wheat middlings, malt sprouts, gluten feed, screenings containing weed seeds partly ground and grit.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4558	Henry & Missert, Buffalo, N. Y. "Holstein Milk Food"	Buffalo	G* 17.35	17.	9.50	Flax seed and flax screenings.
			F* 17.75	12.80	10.18	Flax seed, flax screenings containing weed seeds partly ground and grit.
4306	Henry & Missert, Buffalo, N. Y. "Malt Feed"	South Wales	G 15.75	3.02	11.23	Barley malt and by-product.
			F 15.69	3.30	10.05	As certified.
4367	The H-O Co., Buffalo, N. Y. "De-Fi Feed"	Amenia	G 8.	3.	21.	Oat hulls, oat bran, corn, hominy feed, wheat middlings, oat middlings, salt.
			F 7.56	3.17	15.35	Corn, hominy feed, wheat middlings, oat middlings, oat hulls, salt.
4344	The H-O Co., Buffalo, N. Y. "De-Fi Feed"	Buffalo	G 8.	3.	21.	Oat hulls, oat bran, corn, hominy feed, wheat middlings, oat middlings, salt.
			F 9.31	3.41	12.94	Corn, hominy feed, wheat middlings, oat middlings, oat hulls, salt.
4237	The H-O Co., Buffalo, N. Y. "New England Stock Feed"	Chester	G 9.	4.	9.	Corn, hominy feed, oat hulls, oat bran, oats, salt.
			F 8.81	3.90	9.57	As certified.
4343	The H-O Co., Buffalo, N. Y. "New England Stock Feed"	Buffalo	G 9.	4.	9.	Corn, hominy feed, oat hulls, oat bran, oats, one-half of one per cent salt.
			F 9.44	3.27	8.13	As certified.
4055	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Horse Feed"	Syracuse	G 11.	4.	9.	Oats, oat hulls, gluten feed, oat bran, wheat middlings, corn, hominy feed salt one-half of one per cent.
			F 11.06	3.93	8.85	As certified.

4190	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Horse Feed"	Bergen	G	11.	4.	9.	Oats, oat bran, corn, oat hulls, wheat middlings, hominy feed, gluten feed, one-half of one per cent salt.
			F	11.63	4.28	8.31	As certified.
4372	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Horse Feed"	Brewster	G	11.	4.	9.	Oats, oat hulls, gluten feed, oat bran, wheat middlings, corn, hominy feed, salt.
			F	11.50	4.	9.82	As certified.
4056	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Milk Feed"	Syracuse	G	14.	4.	9.	Oat hulls, wheat middlings, cottonseed meal, oat bran, gluten, corn, oats, salt.
			F	15.31	4.08	7.27	Corn, cottonseed meal, gluten feed, wheat middlings, oat middlings, oat hulls, salt.
4345	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Milk Feed"	Buffalo	G	14.	4.	9.	Oat hulls, wheat middlings, cottonseed meal, oat bran, gluten, corn, oats, salt.
			F	16.81	4.14	10.15	Corn, cottonseed meal, gluten feed, wheat middlings, oat middlings, oat hulls, salt.
4534	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Milk Feed"	Tuckahoe	G	14.	4.	9.	Oat hulls, wheat middlings, cottonseed meal, oat bran, gluten, corn, oats, salt.
			F	16.56	4.08	10.24	Corn, cottonseed meal, gluten feed, wheat middlings, oat middlings, oat hulls, salt.
4349	The H-O Co., Buffalo, N. Y. "The H-O Co's Peerless Stock Feed"	Buffalo	G	8.50	3.25	11.50	Oat hulls, oat bran, hominy feed, corn, salt.
			F	9.81	4.44	10.78	Corn, oat middlings, oat hulls, salt.
4258	Hodgman Milling Co., Painted Post, N. Y. "Chop Feed"	Corning	G	9.06	3.65	——	Corn, oats, oat hulls, barley and oat skimmings, oat middlings.
			F	9.94	3.97	2.79	Corn, corn offal, oats, oat hulls, oat middlings, barley and oat skimmings.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4572	Husted Milling Co., Buffalo, N. Y. "Corn Bran"	Buffalo	G* 8.	5.	9.	Made from corn.
			F* 9.88	5.75	11.49	Corn, corn bran, corn offal.
3838	Husted Milling Co., Buffalo, N. Y. "Fine Ground Eclipse Feed"	Buffalo	G 9.	4.	9.	Corn, oats, oat hulls, middlings, salt three-fourths of one per cent.
			F 11.06	5.41	4.92	As certified.
3997	Husted Milling Co., Buffalo, N. Y. "Husted Dairy Feed"	Auburn	G 20.	4.	9.	Cottonseed meal, gluten, oat clippings, corn, oil meal, middlings, salt three-fourths of one per cent and distillers' grains.
			F 22.88	5.76	6.47	Cottonseed meal, gluten feed, malt sprouts, corn, linseed meal, middlings, distillers' grains, oat clippings, grit, salt.
4144	Husted Milling Co., Buffalo, N. Y. "Husted Dairy Feed'	North Franklin	G 20.	4.	9.	Cottonseed meal, corn, gluten, oat clippings, oil meal, middlings, salt, distillers' grains.
			F 25.94	5.72	6.89	Cottonseed meal, corn, gluten feed, malt sprouts, linseed meal, middlings, distillers' grains, oat clippings, weed seeds, salt.

4564	Husted Milling Co., Buffalo, N. Y. "Husted Dairy Feed"	Buffalo	G	20.	4.	9.	Cottonseed meal, corn, gluten, oat clippings, oil meal, middlings, distillers' grains, salt three-fourths of one per cent.
			F	25.75	5.67	6.91	Cottonseed meal, corn, gluten feed, oat clippings and oat chaff, linseed meal, wheat middlings, distillers' grains, salt.
4566	Husted Milling Co., Buffalo, N. Y. "Husted Horse Feed"	Buffalo	G	12.	4.	9.	Corn, oats, middlings, gluten, oat hulls, oil meal, salt three-fourths of one per cent.
			F	13.19	4.87	6.44	Corn, oats, oat middlings, oat hulls, gluten feed, linseed meal, salt.
3834	Husted Milling Co., Buffalo, N. Y. "Husted Stock Feed"	Buffalo	G	8.	4.	9.	Corn, oats, oat hulls, hominy, middlings, salt three-fourths of one per cent.
			F	10.50	6.20	9.83	As certified.
4278	Husted Milling Co., Buffalo, N. Y. "Husted Stock Feed"	Hamilton	G	8.	4.	9.	Corn, oats, oat hulls, hominy, middlings, salt three-fourths of one per cent.
			F	11.	5.80	5.96	Corn, oats, oat middlings, oat hulls, corn chaff.
4391	Husted Milling Co., Buffalo, N. Y. "Husted Stock Feed"	Buffalo	G	8.	4.	9.	Corn, oats, oat hulls, hominy, middlings, salt three-fourths of one per cent.
			F	10.75	6.51	6.06	Corn, oats, oat middlings, oat hulls.
3835	Husted Milling Co., Buffalo, N. Y. "Husted Yellow Provender"	Buffalo	G	7.	4.	9.	Corn, oats, yellow hominy, oat hulls, salt three-fourths of one per cent.
			F	9.13	3.82	2.90	As certified.
3992	Husted Milling Co., Buffalo, N. Y. "Husted Yellow Provender"	Ithaca	G	7.	4.	9.	Corn, oats, yellow hominy, oat hulls, salt three-fourths of one per cent.
			F	8.28	3.03	4.43	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
				Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:						
4214	Husted Milling Co., Buffalo, N. Y. "Mayflower Stock Feed"	New Paltz	G*	7.50	3.50	9.	Corn, oats, oat hulls, salt.
			F*	9.81	5.09	5.62	Corn, light oats, oat hulls (corn and oat chaff), salt.
4275	Husted Milling Co., Buffalo, N. Y. "Mayflower Stock Feed"	New Berlin	G	7.50	3.50	9.	Corn, oats, oat hulls, salt three-fourths of one per cent.
			F	9.94	5.33	6.38	Corn, light oats, oat hulls (corn and oat chaff), salt.
4565	Husted Milling Co., Buffalo, N. Y. "Mayflower Stock Feed"	Buffalo	G	7.50	3.50	9.	Corn, oats, oat hulls, salt three-fourths of one per cent.
			F	11.38	5.86	5.07	Corn, oats, oat hulls (corn and oat chaff), salt.
4096	Husted Milling Co., Buffalo, N. Y. "Monarch Chop Feed	Syracuse	G	7.50	3.50	9.	Corn, oats, oat hulls, salt three-fourths of one per cent.
			F	9.69	3.88	5.03	Corn, corn chaff, oats, oat hulls, salt.
3238	Husted Milling Co., Buffalo, N. Y. "Monarch Chop Feed"	Watertown	G	7.50	3.50	9.	Corn, oats, oat hulls, salt three-fourths of one per cent.
			F	9.35	4.25	5.52	Corn, oats, oat hulls, salt.
4167	Husted Milling Co., Buffalo, N. Y. "Monarch Chop Feed"	Darien	G	7.50	3.50	9.	Corn, oats, oat hulls, three-fourths of one per cent salt.
			F	9.44	5.02	6.11	Corn, corn chaff, oats, oat hulls, salt.
4351	Husted Milling Co., Buffalo, N. Y. "Monarch Chop Feed"	Pine Bush	G	7.50	3.50	8.	Corn, oats, oat hulls, salt.
			F	10.38	5.31	6.26	Corn, oats, oat hulls, screenings, salt.

4563	Husted Milling Co., Buffalo, N. Y. "Regal Chop"	Buffalo	G F	7. 10.63	3. 5.57	9. 5.10	Corn, oats, oat hulls, three-fourths of one per cent salt. As certified.
4446	Husted Milling Co., Buffalo, N. Y. "Zenith Stock Feed"	Candor	G F	10. 11.44	4. 5.40	9. 5.43	Corn, oats, barley, oat hulls, middlings, salt three-fourths of one per cent. Corn, corn offal, oats, barley, oat middlings, oat hulls, salt.
4601	Husted Milling Co., Buffalo, N. Y. "Zenith Stock Feed"	Nelsonville	G F	10. 11.75	4. 5.21	9. 4.74	Corn, oats, barley, oat hulls, middlings, salt three-fourths of one per cent. Corn, corn offal, oats, barley, oat middlings, oat hulls, salt.
3833	Husted Milling Co., Buffalo, N. Y. "Zenith Stock Feed"	Buffalo	G F	10. 10.19	4. 5.06	9. 5.43	Corn, oats, barley, oat hulls, middlings, salt three-fourths of one per cent. As certified.
4196	Hydraulic Milling Co., Buffalo, N. Y. "Standard Chop Feed"	Buffalo	G F	6.44 9.63	2.53 5.69	6. 7.61	Corn meal, hominy, oat middlings, oat hulls, ground oats. As certified.
4270	Indiana Milling Co., Terre Haute, Ind. "Jersey Mixed Feed"	Oxford	G F	12. 9.19	3. 2.90	15. 16.59	Wheat flour, middlings, wheat bran, cob meal. Wheat bran, cob meal, wheat middlings, wheat flour, salt.
4492	Indiana Milling Co., Terre Haute, Ind. "Sterling Feed"	Binghamton	G F	9.80 9.63	2.75 2.86	14. 17.84	Wheat bran, ground corn, cob meal. As certified.
3831	Indiana Milling Co., Terre Haute, Ind. "Sterling Mixed Feed"	Salamanca	G F	9.80 9.56	2.75 3.01	14. 9.07	Wheat bran, ground corn, cob meal. As certified.
3952	Indiana Milling Co., Terre Haute, Ind. "Sterling Mixed Feed"	Binghamton	G F	9.80 10.07	2.75 3.69	14. 11.18	Wheat bran, ground corn, cob meal. As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4024	Indiana Milling Co., Terre Haute, Ind. "Sterling Mixed Feed"	Malone	G* 9.80	2.75	14.	Wheat bran, ground corn, cob meal.
			F* 10.25	3.09	15.81	Wheat bran, corn and ground corn cob.
4101	Indiana Milling Co., Terre Haute, Ind. "Sterling Mixed Feed"	Altamont	G 9.80	2.75	14.	Wheat bran, ground corn, cob meal.
			F 9.75	3.28	14.32	As certified.
4037	International Stock Food Co., Minneapolis, Minn. "International Grofast Calf Meal"	Copenhagen	G 25.	5.	10.	Fenugreek seed, locust bean, linseed oil meal, dried brewers' grains, cottonseed meal, flaxseed, gluten feed, malt sprouts, pea meal, distillers' dried grains, cleaned grain screenings, red dog flour.
			F 27.94	5.16	7.78	Linseed meal, fenugreek, locust bean meal, cottonseed meal, gluten feed, pea meal, red dog flour, cleaned grain screenings.
4150	International Stock Food Co., Minneapolis, Minn. "International Grofast Calf Meal"	Oneonta	G 25.	5.	10.	Red dog flour, fenugreek seed, locust bean, linseed oil meal, dried brewers' grains, cottonseed meal, flaxseed, gluten feed, malt sprouts, pea meal, distillers' dried grains, cleaned grain screenings.
			F 27.95	5.82	7.35	Linseed meal, fenugreek, locust bean meal, cottonseed meal, gluten feed, pea meal, red dog flour, cleaned grain screenings.

4436	International Stock Food Co., Minneapolis, Minn. "International Grofast Calf Meal"	Tunnell	G	25.	5.	10.	Fenugreek seed, locust bean, linseed oil meal, dried brewers' grains, cottonseed meal, flaxseed, gluten feed, malt sprouts, pea meal, distillers' dried grains, cleaned grain screenings, red dog flour.
			F	28.56	5.82	7.22	Linseed meal, fenugreek, locust bean meal, cottonseed meal, gluten feed, pea meal, red dog flour, cleaned grain screenings.
3991	Jamestown Electric Mills, Jamestown, N. Y. "Jem Feed"	Ithaca	G	8.5	3.	5.	Composed of western corn and oat hulls.
			F	9.07	3.97	8.35	As certified.
4337	Jamestown Electric Mills, Jamestown, N. Y. "Jem Feed"	Machias	G	8.5	3.	5.	Western corn and oat hulls.
			F	9.25	3.28	7.12	As certified.
4510	S. W. Johnson, Haverstraw, N. Y. "Johnson's No. 1 Horse Feed"	Haverstraw	G	14.	5.60	6.40	Oats, oat hulls, hominy, Adrian flour, salt.
			F	13.06	5.20	5.94	Oats, oat hulls, hominy feed, wheat flour, screenings containing weed seeds, salt.
4514	Kornfalfa Feed Milling Co., Kansas City, Mo., "Kornfalfa Feed"	Nanuet	G	10.	3.50	12.	Alfalfa, corn, oats.
			F	12.13	3.40	10.75	Alfalfa, corn, oats, salt.
4507	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Fancy Mixed Feed"	Walden	G	12.	5.	9.	Wheat bran and maizo red dog flour.
			F	13.13	4.50	4.43	Wheat bran, corn meal, red dog flour.
4508	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Wheat Middlings and Maizo Red Dog Flour Mixed"	Walden	G	11.	3.	7.	Maizo red dog flour and wheat middlings.
			F	13.19	5.71	3.43	Corn meal, red dog flour, wheat middlings.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4548	Labar & Lain, Port Jervis, N. Y. "Horse Feed"	Port Jervis	G* 6.50	4.50	12.	Ground oats and corn, oat middlings, oat hulls and one-half of one per cent salt, corn bran and wheat middlings.
			F* 10.94	3.93	5.26	As certified.
3231	Law & Wilber Collins, N. Y. "Square Deal Dairy Ration"	Sandy Creek	G 25.	7.	11.	Corn distillers' grains, hominy and corn meal, owl 41 per cent cottonseed meal, fancy winter wheat bran, old process oil meal, fancy malt sprouts, gluten.
			F 23.75	6.53	7.47	As certified.
4094	Law & Wilber, Collins, N. Y. "Square Deal Dairy Ration"	Auburn	G 25.	7.	11.	Corn distillers' grains, hominy and corn meal, owl 41 per cent cottonseed meal, fancy winter wheat bran, old process oil meal, fancy malt sprouts, gluten.
			F 22.88	6.61	6.20	As certified.
4596	Law & Wilber, Collins, N. Y. "Square Deal Dairy Ration"	Collins	G 25.	7.	11.	Corn distillers' grains, hominy and corn meal, owl 41 per cent cottonseed meal, fancy winter wheat bran, old process oil meal, fancy malt sprouts, gluten.
			F 25.37	6.90	5.76	As certified.

4175	Le Roy Power & Milling Co., Le Roy, N. Y. "Provender"	Le Roy	G F	—— 11.13	—— 3.92	—— 4.89	Corn, oats and screenings. As certified.
3241	The Guy G. Major Co., Toledo, O. "Old Process Oil Meal"	Watertown	G F	30. 29.31	5. 6.05	10. 8.53	Linseed meal, cottonseed meal, cottonseed hulls.
3817	The Guy G. Major Co., Toledo, O. "Old Process Oil Meal"	Brooklyn	G F	30. 29.38	5. 5.91	10. 8.48	Linseed meal, cottonseed meal, cottonseed hulls.
3951	The Guy G. Major Co., Toledo, O. "Old Process Oil Meal"	Binghamton	G F	30. 29.50	5. 5.58	10. 8.61	Linseed meal, cottonseed hulls, cottonseed meal.
4159	The Guy G. Major Co., Toledo, O. "Old Process Oil Meal"	Alden	G F	30. 29.88	5. 6.78	10. 7.53	Linseed meal, cottonseed meal, cottonseed hulls, flax screenings.
4155	J. J. Martin, Perry, N. Y. "Corn, Oats and Bran"	Perry	G F	12.75 11.69	4.89 4.74	4.72 4.25	Corn, wheat, wheat bran, wheat middlings, oats.
4395	Matthews & Harrison, Kingston, N. Y. "Arcade Stock Feed"	Kingston	G	7.50	3.25	13.	Ground corn, ground oats, oat hulls, hominy, wheat middlings, gluten feed and salt.
			F	10.56	5.02	8.59	As certified.
4396	Matthews & Harrison, Kingston, N. Y. "Ulster Chop Feed"	Kingston	G	7.	3.50	10.	Ground corn, ground oats, oat hulls, middlings, hominy, cob meal, oat screenings, barley screenings and salt.
			F	10.31	5.36	8.80	Corn, oats, middlings, oat hulls, hominy feed, corn cob, oat and barley screenings containing weed seeds partly ground, sand, salt.

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ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4402	Mystic Milling & Feed Co., Rochester, N. Y. "Mystic Feed for Horses, Cattle and Swine"	Rochester	G* 14.16	3.4	15.10	Corn meal, rye middlings, cottonseed meal, oat hulls and oat feed.
			F* 10.75	3.30	10.19	Corn meal, wheat, oats, oat middlings, rye middlings, cottonseed meal, oat hulls.
4006	Northern Illinois Cereal Co., Lockport, Ill. "Famous Feed"	Rome	G 8.	4.	——	
			F 8.72	3.21	12.36	Corn, oat middlings, oat hulls.
4701	Northern Illinois Cereal Co., Lockport, Ill. "Famous Feed"	Cortland	G 8.	4.	——	
			F 8.69	3.30	9.12	Corn, oats, oat middlings, oat hulls.
4054	Northern Illinois Cereal Co., Lockport, Ill. "Peru C. & O. Feed"	Syracuse	G 8.	3.50	——	
			F 9.38	3.24	6.29	Cracked corn, oats, oat hulls.
4071	North West Mills Co., Winona, Minn. "Sugarota Calf Meal"	Galena	G 25.	6.	6.	Pulverized wheat, pulverized malt, linseed meal and cottonseed meal.
			F 25.19	5.29	3.57	As certified.
4080	North West Mills Co., Winona, Minn. "Sugarota Milk Meal"	Tully	G 25.	6.	9.	Barley malt sprouts, pure wheat bran, choice cottonseed meal, dried distillers' grains, choice middlings, and a small percentage of salt.
			F 24.56	4.06	10.95	Malt sprouts, wheat bran, cottonseed meal, wheat middlings, salt.

3932	A. Nowak & Son., Buffalo, N. Y. " Buffalo Horse Feed "	Clarence	G	7.	3.	12.	Corn, hominy, oats, oat hulls and middlings.
			F	8.88	3.93	9.12	Corn, hominy feed, oats, oat middlings, oat hulls, wheat middlings (corn and oat screenings).
4314	A. Nowak & Son, Buffalo, N. Y. " Model Chop "	Buffalo	G	6.	2.	12.	Hominy, oat hulls, oat screenings, corn and cob.
			F	9.81	3.53	12.37	Hominy feed, oat hulls, oat and barley screenings containing weed seeds, corn, ground corn cob.
4172	A. Nowak & Son, Buffalo, N. Y. " Model Feed "	Albion	G	18.	1.	14.	Gluten feed — corn and cob.
			F	19.19	3.64	11.98	Gluten feed, ground corn cob.
3225	Ogdensburg Roller Mills, Ogdensburg, N. Y. " Oswegatchie Corn and Oat Chop Feed "	Ogdensburg	G	6.60	3.18	9.	Corn meal, oats, oat hulls and corn cob meal.
			F	7.44	3.17	8.88	As certified.
4329	Olean Mills, Olean, N. Y. " Chop Feed "	Olean	G	7.	2.	8.	Corn, hominy, barley, oats, oat hulls and oat middlings.
			F	8.94	3.55	4.03	Corn, hominy feed, oats, oat hulls, oat middlings, barley, corn offal.
4506	Wm. Orr & Sons, Orr's Mills, N. Y. " Orr's Mixed Feed "	Orr's Mills	G	7.50	2.	——	Corn, oats, rye middlings, wheat middlings.
			F	12.06	4.53	5.83	As certified.
4322	Phelps & Sibley Co., Cuba, N. Y. " White P. & S. Feed "	Cuba	G	7.	4.	8.	White corn, white hominy, oat hulls.
			F	8.19	3.70	5.15	As certified.
4261	Phelps & Sibley Co., Cuba, N. Y. " White P. & S. Feed "	Canisteo	G	7.	4.	8.	White corn, white hominy, oat hulls.
			F	8.56	4.57	5.20	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
				Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:						
4256	Phelps & Sibley Co., Cuba, N. Y. "Yellow P. & S. Feed"	Corning	G*	7.	3.	9.	Western corn and oat hulls.
			F*	8.94	4.81	4.65	Corn, oat hulls.
4309	Phelps & Sibley Co., Cuba, N. Y. "Yellow P. & S. Feed"	Wellsville	G	7.	3.	9.	Western corn and oat hulls.
			F	8.81	4.18	5.08	Corn, oat hulls.
4321	Phelps & Sibley Co., Cuba, N. Y. "Yellow P. & S. Feed"	Cuba	G	7.	3.	9.	Western corn and oat hulls.
			F	8.81	4.29	4.89	Corn, oat hulls.
4516	Phelps & Sibley Co., Cuba, N. Y. "Yellow P. & S. Feed"	Spring Valley	G	7.	3.	9.	Western corn and oat hulls.
			F	8.81	4.27	4.61	Corn, oat hulls.
4362	The Quaker Oats Co., Chicago, Ill. "Boss Feed"	Albany	G	8.	3.	12.	Corn, oat meal mill by-products (oat shorts, oat hulls, oat middlings) salt.
			F	8.94	4.30	9.41	Corn, hominy feed, oat middlings, oat hulls, salt.
4207	The Quaker Oats Co., Chicago, Ill. "C. O. & B. Feed"	Glens Falls	G	10.	3.25	10.	Corn, barley, wheat flour, oat meal mill by-products (oat middlings, oat hulls, oat shorts) cottonseed meal and salt.
			F	11.50	4.67	8.66	As certified.

4335	The Quaker Oats Co., Chicago, Ill. "C. O. and B. Feed Kiln Dried"	Franklinville	G	10.	3.25	10.	Corn, barley, wheat flour, oat meal mill by-products (oat middlings, oat shorts, oat hulls) cottonseed meal and one-half of one per cent salt.
			F	11.13	4.09	9.78	As certified.
4178	The Quaker Oats Co., Chicago, Ill. "Gregson Calf Meal"	Wilson	G	25.	5.	5.	Oat meal, barley, linseed, cottonseed and three-fourths of one per cent salt.
			F	27.94	6.48	4.38	As certified.
4579	The Quaker Oats Co., Chicago, Ill. "Maz-All Feed"	Attica	G	9.50	1.40	2.	Corn by-products.
			F	8.69	1.26	.93	Corn by-products, consisting largely of corn starch, gluten, salt and sugar.
3970	The Quaker Oats Co., Chicago, Ill. "Schumacher Calf Meal"	Union	G	19.	8.	3.	Made from oat meal, wheat meal, ground flaxseed and dried milk.
			F	21.53	6.65	1.48	As certified.
3948	The Quaker Oats Co., Chicago, Ill. "Schumacher Calf Meal"	Java	G	19.	8.	3.	Oat meal, wheat meal, ground flaxseed and dried milk.
			F	18.10	7.21	1.68	As certified.
4118	The Quaker Oats Co., Chicago, Ill. "Schumacher Calf Meal"	Worcester	G	19.	8.	3.	Oat meal, wheat meal, ground flaxseed and dried milk.
			F	19.60	7.95	2.28	As certified.
4015	The Quaker Oats Co., Chicago, Ill. "Schumacher Calf Meal"	Lowville	G	19.	8.	3.	Made from oat meal, wheat meal, ground flaxseed and dried milk.
			F	20.19	7.65	1.99	As certified.
4581	The Quaker Oats Co., Chicago, Ill. "Schumacher Special Horse Feed"	Buffalo	G	9.25	3.25	8.	Corn, oats, oat meal by-products (oat shorts, oat hulls, oat middlings), one-half of one per cent salt.
			F	10.81	4.35	6.65	Corn, oats, oat middlings, oat hulls, salt.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
3222	The Quaker Oats Co., Chicago, Ill. "Schumacher Stock Feed"	Rensselaer Falls	G* 10.	3.25	10.	Made from corn, barley, wheat flour, oat mill by-products (oat shorts, oat hulls, oat middlings), cottonseed meal, and one-half of one per cent salt.
			F* 10.51	3.46	9.66	As certified.
4141	The Quaker Oats Co., Chicago, Ill. "Schumacher Stock Feed"	Oneonta	G 10.	3.25	10.	Corn, barley, wheat flour, oat meal mill by-products (oat shorts, oat hulls, oat middlings), cottonseed meal, salt.
			F 11.25	3.93	8.25	As certified.
3924	The Quaker Oats Co., Chicago, Ill. "Schumacher Stock Feed"	Elba	G 10.	3.25	10.	Corn, wheat flour, barley, oat meal mill by-products (oat shorts, oat hulls, oat middlings), cottonseed meal and one-half of one per cent salt.
			F 11.31	3.63	7.87	As certified.
3966	The Quaker Oats Co., Chicago, Ill. "Schumacher Stock Feed"	Sanitaria Springs	G 10.	3.25	10.	Corn, barley, wheat flour, oat meal mill by-products (oat middlings, oat hulls, oat shorts), cottonseed meal, one-half of one per cent salt.
			F 10.69	4.33	9.03	As certified.
3964	The Quaker Oats Co., Chicago, Ill. "Sterling Feed"	Sanitaria Springs	G 10.	4.	10.	Maximum salt three-quarters of one per cent. Made from corn, oats, barley, cottonseed meal, red dog flour, oat shorts, oat hulls and oat middlings.
			F 10.56	3.98	8.94	As certified.

[illegible]45	The Quaker Oats Co., Chicago, Ill. "Sterling Feed"	Johnsonburg	G	10.	4.	10.	Three-quarters of one per cent salt, corn, oats, barley, cottonseed meal, red dog flour, oat shorts, oat hulls and oat middlings.
			F	11.63	4.49	8.56	As certified.
3249	The Quaker Oats Co., Chicago, Ill. "Sterling Feed"	Fulton	G	10.	4.	10.	Maximum salt, three-quarters of one per cent. Made from corn, oats, barley, cottonseed meal, red dog flour, oat shorts, oat hulls and oat middlings.
			F	10.78	4.16	8.75	As certified.
4206	The Quaker Oats Co., Chicago, Ill. "Sterling Feed"	Whitehall	G	10.	4.	10.	Salt, corn, oats, barley, cottonseed meal, red dog flour, oat shorts, oat hulls and oat middlings.
			F	10.19	4.22	8.84	As certified.
4442	The Quaker Oats Co., Chicago, Ill. "Sterling Stock Feed"	Whitney Point	G	10.	3.25	10.	Corn, barley, wheat flour, oat meal mill by-products (oat middlings, oat hulls, oat shorts), cottonseed meal and one-half of one per cent salt.
			F	11.06	3.87	9.36	As certified.
3928	The Quaker Oats Co., Chicago, Ill. "Victor Feed"	Clarence	G	7.50	3.	12.	Corn, oat meal mill by-products (oat middlings, oat hulls, oat shorts), one-half of one per cent salt.
			F	9.56	4.41	9.27	Corn, corn offal, oat middlings, oat hulls, salt.
4049	The Quaker Oats Co., Chicago, Ill. "Victor Feed"	Amsterdam	G	7.50	3.	12.	Made from corn, oat meal mill by-products (oat shorts, oat hulls and oat middlings) and one-half of one per cent salt.
			F	8.44	4.39	10.22	Corn, corn offal, oat middlings, oat hulls, salt.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4293	The Quaker Oats Co., Chicago, Ill. "Victor Feed"	Geneva	G* 7.50	3.	12.	Corn, oat meal mill by-products (oat shorts, oat hulls, oat middlings) and one-half of one per cent salt.
			F* 8.63	4.40	8.18	Corn, corn offal, oat middlings, oat hulls, salt.
4363	The Quaker Oats Co., Chicago, Ill. "Victor Feed"	Albany	G 7.50	3.	12.	Corn, oat meal mill by-products (oat shorts, oat hulls, oat middlings), salt.
			F 8.38	4.04	9.47	Corn, corn offal, oat middlings, oat hulls, salt.
3237	The Quaker Oats Co., Chicago, Ill. "White Diamond Feed"	Watertown	G 8.	3.25	9.	Made from corn, oat meal mill by-products (oat shorts, oat hulls, oat middlings) and one-half of one per cent salt.
			F 8.82	3.71	5.91	As certified.
3998	The Quaker Oats Co., Chicago, Ill. "White Diamond Feed Fine"	Auburn	G 8.	3.25	9.	Corn, oat meal mill by-products (oat middlings, oat hulls, oat shorts) and one-half of one per cent salt.
			F 9.22	4.28	7.73	As certified.
4582	The Quaker Oats Co., Chicago, Ill. "White Diamond Feed"	Buffalo	G 8.	3.25	9.	Corn, oat meal mill by-products (oat middlings, oat hulls, oat shorts) one-half of one per cent salt.
			F 9.63	4.94	7.86	Corn, oat middlings, oat hulls, salt.

4599	The Randolph Mills, Randolph, N. Y. "Red Mill Perfection Dairy Feed"	Randolph	G	25.	7.	11.	Corn distillers' grains, hominy feed and corn meal, 41 per cent cottonseed meal, fancy winter wheat bran, old process oil meal, fancy malt sprouts, gluten feed.
			F	25.75	7.83	8.40	As certified.
4538	Andrew Ruff's Sons, Troy, N. Y. "Ground Feed"	Troy	G	13.25	4.50	6.	Corn, oats and wheat bran.
			F	13.13	4.39	6.90	As certified.
4528	John Ryan, Port Chester, N. Y. "Sawpit Dairy Feed"	Port Chester	G	8.	6.	20.	Flaxseed, barley, oats, wheat screenings, corn and ground corn cob, oat hulls, one-half of one per cent salt.
			F	10.69	4.33	9.14	Corn, barley, oat middlings, oat hulls, ground flaxseed, screenings containing weed seeds partly ground, ground corn cob, salt.
3814	Shaw & Truesdell Co., Brooklyn, N. Y. "Ground Feed"	Brooklyn	G	9.43	3.07	10.04	Oat hulls, corn.
			F	11.31	3.50	3.94	Corn meal, bean meal, light oats, oat hulls.
3813	Shaw & Truesdell Co., Brooklyn, N. Y. "Santico Feed"	Brooklyn	G	9.62	3.04	5.87	Barley, oat feed, wheat middlings, corn.
			F	10.50	3.86	4.20	Barley, corn meal, oats, oat middlings, oat hulls, wheat middlings.
4197	Stein & Wittlin, Buffalo, N. Y. "Buffalo Dairy Feed"	Buffalo	G	19.50	2.60	15.	Gluten feed, cottonseed meal, flour, oil meal, ground corn and cob.
			F	15.31	3.12	13.43	Gluten feed, cottonseed meal, wheat flour, corn and cob meal, salt.
4198	Stein & Wittlin, Buffalo, N. Y. "Buffalo Stock Feed"	Buffalo	G	9.	3.	10.	Hominy, yellow corn, oil meal, oat shorts and barley shorts.
			F	8.81	5.23	7.21	Corn, hominy feed, barley, oats, oat middlings, linseed meal, screenings.

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ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4259	Stephen Hollands & Sons, Hornell, N. Y. "No. 2 Feed"	Hornell	G* 11.75	4.	5.	Corn meal, wheat bran and wheat middlings.
			F* 12.31	4.46	4.24	As certified.
4432	J. H. Strait Milling Co., Canisteo, N. Y. "No. 2 Chop Feed"	Canisteo	G 7.	5.	15.	Hominy, oat hulls, grain screenings, and tolls from grists.
			F 9.38	3.17	5.80	Corn, corn offal, hominy feed, oat hulls, buckwheat hulls, grit.
4249	Thompson & Mould, Goshen, N. Y. "Mixed Feed"	Johnsons	G 14.	3.5	7.5	Wheat bran, wheat middlings, wheat screenings, corn bran.
			F 16.94	4.76	6.39	As certified.
3975	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Stock Feed"	Waverly	G 10.50	7.	13.25	Corn offal, hominy, gluten, oat middlings, oat hulls.
			F 12.13	4.98	8.36	As certified.
4243	Tioga Mill & Elevator Co., Waverly, N. Y. "Derby Stock Feed"	Middletown	G 10.50	7.	13.25	Corn offal, hominy, gluten, oat middlings, oat hulls.
			F 12.38	4.65	8.56	Corn, corn offal, hominy feed, gluten feed, oat middlings, oat hulls.
3976	Tioga Mill & Elevator Co., Waverly, N. Y. "Economy Feed"	Waverly	G 10.	5.	17.25	Hominy, brewers' grains, corn offal, cob meal, oat hulls and oat middlings.
			F 10.70	4.54	13.35	As certified.
4205	Tioga Mill & Elevator Co., Waverly, N. Y. "Economy Feed"	Whitehall	G 10.	5.	17.25	Corn offal, hominy, brewers' grains, cob meal, oat hulls, oat middlings.
			F 10.88	4.09	14.18	As certified.

3843	Geo. Tomlinson & Son, Perry, N. Y. "Chop Feed"	Perry	G	11.31	4.51	4.59	Corn, oats and bran.
			F	12.63	4.77	6.39	As certified.
3968	The Toledo Elevator Co., Toledo, O. "Star Feed"	Sanitaria Springs	G	7.	5.50	12.50	Hominy feed, corn and ground corn cob, one-half of one per cent salt.
			F	9.60	6.76	8.78	As certified.
3980	The Toledo Elevator Co., Toledo, O. "Star Feed"	Waverly	G	8.	6.	9.	Hominy feed, corn and ground corn cob, containing one-half of one per cent salt.
			F	9.72	7.41	7.32	As certified.
4244	The Toledo Elevator Co., Toledo, O. "Star Feed"	Middletown	G	7.	5.50	12.50	Hominy feed, corn and ground corn cob.
			F	9.50	6.88	9.28	As certified.
4328	The Toledo Elevator Co., Toledo, O. "Star Feed"	Bolivar	G	7.	5.50	12.50	Hominy feed, corn and ground corn cob, salt one-half of one per cent.
			F	9.63	5.62	11.45	As certified.
3847	The Toledo Grain & Milling Co., Toledo, O. "Camp's M. D. Chop Feed"	Little Valley	G	7.	3.50	9.	White or yellow ground corn, ground oats, oat middlings, oat groats, and oat hulls.
			F	8.69	3.33	5.64	Corn, wheat bran, oats, oat middlings, oat hulls, ground corn cob.
4357	A. Waller & Co., Henderson, Ky. "Blue Grass Feed"	Roxbury	G	9.11	2.3	15.17	Winter wheat middlings, ground corn and cob.
			F	10.31	2.95	15.06	Wheat bran, wheat middlings, ground corn and cob.
4004	A. Waller & Co., Henderson, Ky. "Oneida Mixed Feed"	Camden	G	10.	2.50	17.	Winter wheat bran, winter wheat middlings, ground corn and cob.
			F	9.91	2.81	14.59	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COMPOUNDED FEEDS:					
4076	A. Waller & Co., Henderson, Ky. "Oneida Mixed Feed"	Canastota	G* 10.	2.50	17.	Winter wheat bran, winter wheat middlings, ground corn and cob.
			F* 10.25	3.12	11.45	As certified.
4164	The Otto Weiss Alfalfa Stock Food Co., Wichita, Kan. "Otto Weiss Alfalfa Stock Food for Horses and Cows"	Alden	G 11.	3.50	14.	Alfalfa, corn chop, bran, shorts, linseed oil meal, three-fourths of one per cent salt.
			F 13.25	3.43	7.59	Alfalfa, cracked corn, wheat bran, small amount of linseed meal, salt.
4533	The Otto Weiss Alfalfa Stock Food Co., Wichita, Kan. "Otto Weiss Alfalfa Stock Food"	Mount Vernon	G 11.	3.50	14.	Alfalfa, corn chop, bran, shorts, linseed oil meal and three-fourths of one per cent salt.
			F 13.31	3.30	12.36	Alfalfa meal, cracked corn, wheat bran, wheat middlings, linseed meal, salt.
4505	Frank C. Wessells, Mountainville, N. Y. "Feed"	Mountainville	G 6.	2.	——	Oats, corn and wheat middlings, salt.
			F 12.50	4.60	3.96	As certified.
3912	Western Grain Products Co., Hammond, Ind. "Hammond Stock Feed"	Watts Flats	G 10.	4.	9.	Corn, barley, oat hulls, oat middlings, cottonseed meal and one-half of one per cent salt.
			F 9.44	2.38	7.90	Corn, corn offal, barley, oat middlings, cottonseed meal, oat hulls, salt.

4191	W. J. Wheelock Co., Greigsville, N. Y. "Banner Horse Feed"	Batavia	G	12.	4.	9.	Oats, corn, oil meal, gluten, middlings, oat hull, three-fourths of one per cent salt.
			F	14.	5.16	5.67	Corn, oats, linseed meal, gluten feed wheat middlings, oat hulls, salt.
	MOLASSES FEEDS (COMPOUNDED):						
4228	American Milling Co., Chicago, Ill. "Amco Dairy Feed"	Florida	G	18.	3.	10.	Gluten, cottonseed meal, oat clips and molasses, salt.
			F	20.25	6.20	8.63	Gluten feed, cottonseed meal, oat clippings and screenings, molasses, salt.
4008	American Milling Co., Chicago, Ill. "Sucrene Dairy Feed"	Rome	G	16.50	3.50	12.	Cottonseed meal, gluten feed, molasses, oat clippings and wheat, oat and barley screenings, one-half of one per cent salt.
			F	17.	3.61	10.84	Cottonseed meal, gluten feed, oat clippings (wheat, oat and barley screenings, containing weed seeds partly ground), sand, salt, molasses.
4082	American Milling Co., Chicago, Ill. "Sucrene Dairy Feed"	Preble	G	16.50	3.50	12.	Cottonseed meal, gluten feed, molasses, oat clippings and wheat, oat and barley screenings, one-half of one per cent salt.
			F	18.31	4.83	9.48	Cottonseed meal, gluten feed, oat clippings (wheat, oat and barley screenings containing weed seeds partly ground), sand, salt, molasses.
4215	American Milling Co., Chicago, Ill. "Sucrene Dairy Feed"	New Paltz	G	16.50	3.50	12.	Cottonseed meal, gluten feed, molasses, oat clippings and wheat, oat and barley screenings, salt.
			F	18.44	3.93	9.44	Cottonseed meal, gluten feed, oat clippings (wheat, oat and barley screenings, containing ground weed seeds), sand, salt, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4327	American Milling Co., Chicago, Ill. "Sucrene Dairy Feed"	Bolivar	G* 16.50	3.50	12.	Cottonseed meal, oats, barley, wheat, grain screenings, malt sprouts, molasses, one-half of one per cent salt.
			F* 18.00	5.05	12.08	Cottonseed meal, malt sprouts, oat clippings (screenings from corn, wheat, oats and barley, containing weed seeds and grit), salt, molasses.
4612	Erler & Co., Riverhead, N. Y. "Erler's Old German Molasses Feed for Horses, Cattle, Poultry, Pigs"	Riverhead	G 10.08	3.	3.63	Made from best corn meal, wheat bran, oil meal, molasses and one per cent salt.
			F 8.89	4.40	2.44	Molasses, wheat bran, corn meal, linseed meal.
4310	Faramel Manufacturing Co., Buffalo, N. Y. "Faramel Dairy Feed"	Buffalo	G 17.94	2.69	6.30	Gluten, molasses, malt sprouts, bran.
			F 19.60	2.13	5.78	As certified.
4304	Faramel Manufacturing Co., Buffalo, N. Y. "Faramel Horse Feed"	Buffalo	G 10.44	4.24	5.25	Oats, corn, wheat bran and molasses.
			F 10.50	3.98	4.39	As certified.
3827	Globe Molasses Feed Co., Brooklyn, N. Y. "Globe Molasses Feed"	Brooklyn	G 4.05	.25	13.25	Ground oats, whole grain screenings, cracked corn, whole rye, cane molasses.
			F 6.19	1.51	8.84	As certified.

4040	F. W. Goeke & Co., St. Louis, Mo. "Atlas Dairy Feed"	Waterville	G	20.	4.	12.	Composed of wheat, corn, oats, barley, brewers' grains, malt sprouts, alfalfa meal, cottonseed meal, salt, screenings and molasses.
			F	21.50	5.38	10.82	Low grade wheat, corn, brewers' grains, malt sprouts, alfalfa meal, cottonseed meal, salt, screenings containing ground weed seeds and grit, ground cocoa shells, molasses.
4280	F. W. Goeke & Co., St. Louis, Mo. "Atlas Dairy Feed"	Morrisville Station	G	20.	4.	12.	Wheat, corn, oats, barley, brewers' grains, malt sprouts, alfalfa meal, cottonseed meal, salt, screenings and molasses.
			F	18.56	5.04	10.55	Low grade wheat, corn, brewers' grains, malt sprouts, alfalfa meal, cottonseed meal, screenings containing weed seeds partly ground, sand, cocoa shells, salt, molasses.
4504	F. W. Goeke & Co., St. Louis, Mo. "Atlas Dairy Feed"	Washington-ville	G	20.	4.	12.	Wheat, corn, oats, barley, brewers' grains, malt sprouts, alfalfa meal, cottonseed meal, salt, screenings and molasses.
			F	20.75	6.35	10.75	Low grade wheat, corn, brewers' grains, malt sprouts, alfalfa meal, cottonseed meal, screenings containing ground weed seeds, cocoa shells, grit, salt, molasses.
4136	F. W. Goeke & Co., St. Louis, Mo. "Holstein Sugar Feed"	Cooperstown	G	15.	3.	15.	Molasses, wheat, corn, oats, barley, cottonseed meal, mill feed, alfalfa meal and screenings.
			F	15.31	4.22	7.42	Cottonseed meal, low grade wheat, alfalfa meal, malt sprouts (wheat, corn, oats and barley screenings, containing weed seeds partly ground), sand, light oats, ground cocoa shells, salt, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4411	F. W. Goeke & Co., St. Louis, Mo. "Holstein Sugar Feed"	Cincinnatus	G* 15.	3.	15.	Molasses, wheat, corn, oats, barley, cottonseed meal, malt sprouts, alfalfa meal, salt and screenings.
			F* 13.88	3.33	11.64	Cottonseed meal, low grade wheat, alfalfa meal, malt sprouts (wheat, oat, corn and barley screenings containing weed seeds partly ground), light oats, sand, salt, molasses.
4455	F. W. Goeke & Co., St. Louis, Mo. "Holstein Sugar Feed	New Hartford	G 15.	3.	15.	Composed of molasses, wheat, corn, oats, barley, cottonseed meal, malt sprouts, alfalfa meal, salt and screenings.
			F 14.81	3.56	9.70	Cottonseed meal, low grade wheat, alfalfa meal, malt sprouts (wheat, corn, oat and barley screenings containing weed seeds partly ground), light oats, sand, salt, molasses.
4385	F. W. Goeke & Co., St. Louis, Mo. "Sugar Ring Feed"	Cherry Valley	G 11.	4.	12.	Wheat, corn, oats, barley, alfalfa meal, rice bran, screenings and molasses.
			F 11.54	2.37	8.80	Wheat, corn, oats, barley, alfalfa meal, rice bran, rice hulls, screenings, grit, molasses.
4468	The Great Western Cereal Co., Chicago, Ill. "Daisy Dairy Feed"	Plattsburgh	G 15.	3.	12.	Maximum salt, three-quarters of one per centum. Made from oats, cottonseed meal, alfalfa meal, oat middlings, oat shorts, oat hulls and N. O. molasses.
			F 18.50	3.04	11.34	Oats, cottonseed meal, alfalfa meal, oat middlings, oat hulls, salt, molasses.

4580	The Great Western Cereal Co., Chicago, Ill. "Daisy Dairy Feed"	Attica	G	15.	3.	12.	
			F	20.	4.11	14.65	Cottonseed meal, oat hulls, screenings, molasses.
3916	Husted Milling Co., Buffalo, N. Y. "Husted's Alfalfa Horse Feed"	Batavia	G	10.	2.	15.	Alfalfa, corn, barley, oil meal, molasses, oat clippings, oats, salt.
			F	12.56	2.90	11.94	Alfalfa, corn, barley, oil meal, cottonseed meal, oats, oat clippings, oat chaff, salt, molasses.
4199	Husted Milling Co., Buffalo, N. Y. "Husted Alfalfa Horse Feed"	Marilla	G	10.	3.	15.	Alfalfa, corn, barley, oil meal, molasses, oats, oat clippings, salt, three-fourths of one per cent.
			F	13.63	3.44	12.37	Alfalfa, corn, oats, linseed meal, cottonseed meal, oat clippings, oat chaff, salt, molasses.
4390	Husted Milling Co., Buffalo, N. Y. "Husted Alfalfa Horse Feed"	Hudson	G	10.	2.	15.	Alfalfa, corn, barley, cottonseed meal, molasses, oats, oat clippings, salt.
			F	13.56	3.37	12.53	Alfalfa, corn, oats, linseed meal, cottonseed meal, oat clippings, oat chaff, salt, molasses.
4416	Husted Milling Co., Buffalo, N. Y. "Husted Alfalfa Horse Feed"	Syracuse	G	10.	2.	15.	Alfalfa, corn, barley, cottonseed meal, molasses, oats, oat clippings, salt, three-fourths of one per cent.
			F	12.94	3.32	11.46	Alfalfa, corn, oats, linseed meal, cottonseed meal, oat clippings, oat chaff, salt, molasses.
4569	Husted Milling Co., Buffalo, N. Y. "Molasses Corn Flakes"	Buffalo	G	7.	5.	9.	Corn bran, molasses.
			F	8.28	4.67	8.86	As certified.
4570	Husted Milling Co., Buffalo, N. Y. "Husted Germaline"	Buffalo	G	9.	3.	4.	Corn meal, molasses.
			F	9.06	4.35	1.53	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4200	Husted Milling Co., Buffalo, N. Y. " Husted Molasses Feed "	Marilla	G* 18.	4.	9.	Cottonseed meal, gluten, oat clippings, corn, oil meal, molasses, salt, three-fourths of one per cent and distillers' grains.
			F* 23.13	5.36	6.64	Cottonseed meal, gluten feed, malt sprouts, distillers' grains, oil meal, corn (oat clippings and screenings containing weed seeds partly ground and grit), salt, molasses.
4050	Husted Milling Co., Buffalo, N. Y. " Husted Molasses Feed "	Little Falls	G 18.	4.	9.	Cottonseed meal, gluten, oat clippings, corn, oil meal, molasses, salt three-quarters of one per cent and distillers' grains.
			F 22.	5.10	7.42	Cottonseed meal, gluten feed, malt sprouts, distillers' grains, oil meal, corn, oat clippings, screenings containing weed seeds partly ground, salt, molasses.
4143	Husted Milling Co., Buffalo, N. Y. " Husted Molasses Feed "	North Franklin	G 18.	4.	9.	Cottonseed meal, gluten, oat clippings, corn, oil meal, molasses, salt, distillers' grains.
			F 25.19	5.57	6.94	Cottonseed meal, gluten feed, malt sprouts, distillers' grains, oil meal, corn, (oat clippings and screenings containing weed seeds partly ground and grit), salt, molasses.

3994	Husted Milling Co., Buffalo, N. Y. "Husted Molasses Feed"	Ithaca	G	18.	4.	9.	Cottonseed meal, gluten, oat clippings, corn, oil meal, molasses, salt three-quarters of one per cent and distillers' grains.
			F	25.13	5.27	6.68	Cottonseed meal, gluten feed, malt sprouts, distillers' grains, oil meal, corn (oat clippings and screenings containing weed seeds partly ground and grit), salt, molasses.
3832	Husted Milling Co., Buffalo, N. Y. "Husted Oatmolene Horse Feed"	Buffalo	G	9.	3.	7.	Ground oats, cracked corn, corn meal, wheat bran, molasses.
			F	9.37	3.99	3.23	As certified.
4573	Husted Milling Co., Buffalo, N. Y. "Molasses Horse Feed"	Buffalo	G	7.	3.	9.	Corn, oats, oat clippings, middlings, molasses, salt, three-fourths of one per cent.
			F	10.94	4.78	5.66	Corn, oats (oat clippings and screenings containing weed seeds partly ground, oat hulls), wheat middlings, cottonseed meal, grit, salt, molasses.
4283	Husted Milling Co., Buffalo, N. Y. "Molasses Horse Feed"	Munnsville	G	7.	3.	9.	Corn, oats, oat clippings, middlings, molasses, salt, three-fourths of one per cent.
			F	11.19	4.03	5.84	Corn distillers' grains, wheat middlings, light oats, oat clippings and screenings, salt, molasses.
3243	International Sugar Feed Co., Minneapolis, Minn. "International Dairy Feed"	Evans Mills	G	16.50	3.50	12.	Cottonseed meal, molasses, cleaned grain screenings, oat clips, salt.
			F	19.75	5.47	10.79	Cottonseed meal, grain screenings and weed seeds partly ground, oat clippings and oat hulls, salt, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4437	International Sugar Feed Co., Minneapolis, Minn. " International Dairy Feed "	Windsor	G* 16.50	3.50	12.	Cottonseed meal, molasses, cleaned grain screenings, oat clips, salt.
			F* 19.75	4.48	11.61	Cottonseed meal, oat clippings, oat hulls, screenings containing weed seeds partly ground, grit, salt, molasses.
4472	International Sugar Feed Co., Minneapolis, Minn. " International Horse Feed "	Little Falls	G 12.50	3.50	12.	Oats, barley, corn, alfalfa, oil meal, cottonseed meal, cleaned grain screenings, oat clips, molasses and salt.
			F 14.81	4.04	12.12	Corn, alfalfa, oil meal, cottonseed meal, screenings containing weed seeds, oat clippings, oat hulls, grit, salt, molasses.
3984	International Sugar Feed Co., Minneapolis, Minn. " International Special Molasses Feed "	Whitney's Point	G 12.50	3.50	12.	Cottonseed meal, molasses, cleaned grain screenings, oat clips, salt.
			F 17.	6.27	11.06	Cottonseed meal (grain screenings containing weed seeds partly ground), oat clippings, sand, salt, molasses.
4113	International Sugar Feed Co., Minneapolis, Minn. " International Special Molasses Feed "	Richmondville	G 12.50	3.50	12.	Cottonseed meal, molasses, cleaned grain screenings, oat clips, salt.
			F 16.19	5.25	11.53	Cottonseed meal (grain screenings containing weed seeds partly ground), oat clippings, sand, salt, molasses.

4451	International Sugar Feed Co., Minneapolis, Minn. "International Special Molasses Feed"	Little Falls	G	12.50	3.50	12.	Cottonseed meal, molasses, cleaned grain screenings, oat clips, salt.
			F	14.31	3.99	11.29	Cottonseed meal (grain screenings containing weed seeds partly ground), oat clippings, sand, salt, molasses.
4230	Kingfalfa Mills, Nebraska City, Neb. "Kingfalfa Horse Feed"	Monroe	G	10.25	3.25	12.	Alfalfa, corn, oats, syrup.
			F	11.20	2.29	8.91	As certified.
4048	Kingfalfa Mills, Nebraska City, Neb. "P. Green Horse Feed"	Amsterdam	G	10.25	3.25	12.	Alfalfa, corn, oats, syrup.
			F	11.38	2.54	8.60	Alfalfa, corn, oats, molasses.
4503	Kornfalfa Mills, Nebraska City, Neb. "Meadow Feed"	Washington-ville	G	11.	2.	17.	Alfalfa meal and molasses.
			F	12.10	1.03	16.56	As certified.
4590	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Alfalfa Horse and Mule Feed"	Buffalo	G	10.	2.	12.	Corn, oats, alfalfa and syrup.
			F	11.01	2.58	8.68	Alfalfa, corn, oats, molasses.
4212	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Alfalfa Horse and Mule Feed"	New Paltz	G	10.	2.	12.	Corn, oats, alfalfa and syrup.
			F	11.66	2.43	8.53	Alfalfa, corn, oats, molasses.
4440	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Alfalfa Horse and Mule Feed"	Windsor	G	10.	2.	12.	Corn, oats, alfalfa and syrup.
			F	11.90	2.53	10.44	Alfalfa, corn, oats, molasses.
4121	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Dairy Feed"	Schenevus	G	16.	2.	15.	Cottonseed meal, corn, oil meal, malt sprouts, dried grains, alfalfa meal and molasses, salt.
			F	16.94	2.07	7.81	Corn, malt sprouts, alfalfa meal, dry brewers' grains, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4439	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Dairy Feed"	Windsor	G* 16.	2.	15.	Cottonseed meal, corn, oil meal, malt sprouts, dried grains, alfalfa meal and molasses, one-half of one per cent salt.
			F* 16.39	1.95	10.87	Cottonseed meal, corn, malt sprouts, dried brewers' grains, alfalfa meal, molasses.
4211	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Ever Green Feed"	New Paltz	G 10.	1.	30.	Made from alfalfa and syrup.
			F 13.46	1.02	12.70	Alfalfa, molasses.
4438	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Ever Green Feed"	Windsor	G 10.	1.	30.	Made from alfalfa and syrup.
			F 13.19	1.09	13.94	Alfalfa, molasses.
4550	The Larrowe Milling Co., Detroit, Mich. "Dried Beet Pulp and Molasses"	Guilderland Center	G 9.	.50	18.	Dried beet pulp 90 per cent, beet molasses 10 per cent.
			F 9.56	1.14	18.44	As certified.
4497	The Larrowe Milling Co., Detroit, Mich. "Dried Molasses Beet Pulp"	Bainbridge	G 9.	.50	18.	Composed only of residue of sugar beets after extraction of sugar, mixed with molasses and dried.
			F 8.75	.81	14.89	As certified.
4605	The Meader-Atlas Co., New York, N. Y. "Atlas Horse Feed"	Yonkers	G 5.	1.	12.	Oats, corn, dried brewers' grains, molasses, oat hulls, ground hay.
			F 6.37	1.57	7.16	As certified.

4378	The Meader-Atlas Co., New York, N. Y. "Blue Bell Cow Feed"	Rhinebeck	G	10.	2.	12.	Corn, dried brewers' grains, molasses, cottonseed meal, oat hulls, ground hay.
			F	9.15	2.17	10.51	Dried brewers' grains, cottonseed meal, oat hulls, ground hay, large amount of screenings containing weed seeds, sand, molasses.
4023	North-West Mills Co., Winona, Minn. "Sugarota Dairy Feed"	Chateaugay	G	16.50	3.5	14.	Cottonseed meal, ground flax shives, broken flaxseed and flax pods, malt sprouts, wheat screenings, molasses and salt.
			F	17.56	5.30	12.65	Cottonseed meal, ground flax shives, broken flaxseeds, and flax pods, malt sprouts (screenings containing weed seeds partly ground, and grit), salt, molasses.
4417	North-West Mills Co., Winona, Minn. "Sugarota Dairy Feed"	Erieville	G	16.50	3.50	14.	Cottonseed meal, ground flax shives, broken flaxseed and flax pods, wheat screenings, malt sprouts, molasses and salt.
			F	17.	4.84	15.	Cottonseed meal, flax bran, malt sprouts, screenings containing weed seeds partly ground, salt, grit, molasses.
4484	North-West Mills Co., Winona, Minn. "Sugarota Horse Feed"	Fayetteville	G	12.	3.	14.	Made from corn, oats, barley, oat clips, molasses, small per cent of salt.
			F	8.90	2.50	8.37	Corn, oats, oat clippings, oat hulls, screenings containing ground weed seeds, molasses.
4165	Omaha Alfalfa Milling Co., Omaha, Neb. "Al-Fal-Co. Horse and Mule Feed"	Alden	G	10.	3.	12.	Ground alfalfa, corn, oats, molasses.
			F	11.63	2.67	8.07	As certified.

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ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4589	Omaha Alfalfa Milling Co., Omaha, Neb. "Al-Fal-Co. Horse and Mule Feed"	Buffalo	G* 10. F* 10.59	3. 2.22	12. 7.52	Ground alfalfa, corn, oats, molasses. As certified.
4593	Omaha Alfalfa Milling Co., Omaha, Neb. "Al-Fal-Co. Horse and Mule Feed"	Buffalo	G 10. F 10.30	3. 2.35	12. 7.89	Ground alfalfa, corn, oats, molasses. As certified.
4188	Omaha Alfalfa Milling Co., Omaha, Neb. "Green Meadow Dairy Feed"	Hunt	G 11. F 11.67	1. .74	25. 13.71	Alfalfa meal and molasses. As certified.
4537	Omaha Alfalfa Milling Co., Omaha, Neb. "Mofalfa"	White Plains	G 10. F 11.31	1. .86	25. 15.17	Molasses, alfalfa. As certified.
4325	Omaha Alfalfa Milling Co., Omaha Neb. "Perfection Horse Feed"	Cuba	G 10.50 F 11.43	3. 2.77	12. 7.23	Corn, oats, alfalfa meal, molasses. As certified.
4515	Omaha Alfalfa Milling Co., Omaha, Neb. "Perfection Horse Feed"	Spring Valley	G 10.50 F 11.44	3. 2.89	12. 9.67	Corn, oats, alfalfa meal, molasses. As certified.
4530	M. C. Peters Mill Co., Omaha, Neb. "June Pasture Dairy Meal"	Port Chester	G 10. F 11.80	.50 .94	26. 16.84	Pure ground alfalfa and fine molasses. As certified.

4531	M. C. Peters Mill Co., Omaha, Neb. "Peters' Arab Horse Feed"	Port Chester	G	9.	2.	15.	Corn, oats, alfalfa and molasses.
			F	10.30	2.36	9.25	As certified.
4591	M C. Peters Mill Co., Omaha, Neb. "Peters' Arab Horse Feed"	Buffalo	G	9.	2.	15.	Corn, oats, alfalfa and molasses.
			F	10.46	2.44	7.37	As certified.
4029	The Quaker Oats Co., Chicago, Ill. "Blue Ribbon Dairy Feed"	Malone	G	25.	4.50	9.	Made from cottonseed meal, malt sprouts, bran, corn, oat meal mill by-products (oat shorts, oat hulls and oat middlings), and molasses.
			F	25.07	4.10	9.88	As certified.
3967	The Quaker Oats Co., Chicago, Ill. "Blue Ribbon Dairy Feed"	Sanitaria Springs	G	25.	4.	9.	Wheat bran, cottonseed meal, malt sprouts, corn, molasses, oat meal mill by-products (oat middlings, oat hulls, oat shorts), one-half of one per cent salt.
			F	25.26	4.85	9.92	Cottonseed meal, wheat bran, malt sprouts, corn, oat middlings, oat hulls, molasses.
4204	The Quaker Oats Co., Chicago, Ill. "Blue Ribbon Dairy Feed"	Whitehall	G	25.	4.	9.	Salt, wheat bran, cottonseed meal, malt sprouts, corn, molasses, oat meal mill by-products, oat middlings, oat hulls, oat shorts.
			F	28.26	4.92	8.53	Cottonseed meal, malt sprouts, wheat bran, corn, oat middlings, oat hulls, molasses.
4158	The Quaker Oats Co., Chicago, Ill. "Blue Ribbon Dairy Feed"	Warsaw	G	25.	4.50	9.	Cottonseed meal, malt sprouts, bran, corn, oat meal mill by-products (oat shorts, oat hulls, oat middlings), and molasses.
			F	26.12	4.41	6.92	Cottonseed meal, malt sprouts, wheat bran, corn, oat middlings, oat hulls, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4203	The Quaker Oats Co., Chicago, Ill. "Daisy Dairy Feed"	Whitehall	G* 15.	3.	12.	Salt, oats, cottonseed meal, alfalfa meal, oat middlings, oat shorts, oat hulls, and N. O. molasses.
			F* 18.56	2.78	10.89	Oats, cottonseed meal, alfalfa meal, oat middlings, oat hulls, salt, molasses.
4084	The Quaker Oats Co., Chicago, Ill. "Daisy Dairy Feed"	Killawog	G 15.	3.	12.	Maximum salt three-quarters of one per cent. Made from oats, cottonseed meal, alfalfa meal, oat middlings, oat shorts, oat hulls and N. O. molasses.
			F 18.88	2.89	8.74	Oats, cottonseed meal, alfalfa meal, oat middlings, oat hulls, salt, molasses.
4595	The Quaker Oats Co., Chicago, Ill. "Green Cross Horse Feed"	Buffalo	G 10.	3.25	9.	Alfalfa, corn, oats, molasses, oat meal mill by-products (oat middlings, oat hulls, oat shorts), cottonseed meal, one-half of one per cent salt.
			F 10.86	2.79	7.14	Alfalfa, corn, oats, oat middlings, oat hulls, cottonseed meal, salt, molasses.
3940	The Quaker Oats Co., Chicago, Ill. "Quaker Dairy Molasses Feed"	Attica	G 16.	3.50	12.	Grain screenings, flax pods and stalks, oat meal mill by-products (oat shorts, oat hulls, oat middlings), cottonseed meal, half of one per cent salt, molasses.
			F 17.41	4.72	12.08	Cottonseed meal, malt sprouts (grain screenings containing weed seeds, partly ground and grit), flax pods and stalks, oat middlings, oat hulls, salt, molasses.

3965	The Quaker Oats Co., Chicago, Ill. "Quaker Dairy Molasses Feed"	Sanitaria Springs	G	16.	3.50	12.	Made from grain screenings, flax pods and stalks, oat meal mill by-products (oat hulls, oat middlings and oat shorts), cottonseed meal and molasses.
			F	13.	3.18	12.77	Cottonseed meal (grain screenings containing weed seeds partly ground), sand, flax pods and stalks, oat middlings, oat hulls, molasses.
4463	The Quaker Oats Co., Chicago, Ill. "Quaker Dairy Molasses Feed"	Saranac Lake	G	16.	4.	13.	Cottonseed meal, malt sprouts, molasses, grain screenings, oat meal mill by-products (oat middlings, oat hulls, oat shorts), flax pods and stalks and one-half of one per cent salt.
			F	16.94	4.98	14.05	Cottonseed meal, malt sprouts, oat middlings, oat hulls, grain screenings containing weed seeds partly ground, flax screenings, grit, molasses.
4112	The Quaker Oats Co., Chicago, Ill. "Quaker Molasses Dairy Feed"	Richmondville	G	16.	3.50	12.	Cottonseed meal, molasses, grain screenings, oat meal mill by-products, oat middlings, oat hulls, oat shorts, flax pods and stalks, salt.
			F	16.56	4.37	11.05	Cottonseed meal, (grain screenings containing weed seeds partly ground), sand, flax pods and stalks, oat middlings, oat hulls, molasses.
4544	The Quaker Oats Co., Chicago, Ill. "Quaker Molasses Dairy Feed"	Delhi	G	16.	3.50	12.	Cottonseed meal, molasses, grain screenings, oat meal mill by-products (oat middlings, oat hulls, oat shorts), flax pods and stalks, half of one per cent salt.
			F	16.81	4.57	13.13	Cottonseed meal, grain screenings containing large amount of weed seeds partly ground, oat middlings, oat hulls, flax screenings, grit, molasses.

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ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4376	Ralston Purina Co., St. Louis, Mo. "Purina Molasses Feed"	Poughkeepsie	G* 11.5	4.5	10.	Corn, oats, ground grain screenings, ground alfalfa and molasses.
			F* 9.48	2.81	10.01	Corn, oats, alfalfa meal, grain screenings, salt, molasses.
3956	The Sugarine Co., Chicago, Ill. "Sugarine Dairy Feed"	Binghamton	G 16.50	3.50	12.	Cottonseed meal, oats, barley, wheat, grain screenings, gluten and molasses, one-half of one per cent salt.
			F 17.25	4.35	9.75	Cottonseed meal, gluten feed, (screenings from corn, oats, barley and wheat), sand, molasses.
4148	The Sugarine Co., Chicago, Ill. "Sugarine Dairy Feed"	Oneonta	G 16.50	3.50	12.	Cottonseed meal, oats, barley, wheat, grain screenings, gluten, molasses, salt.
			F 16.88	4.12	9.67	Cottonseed meal, gluten feed, (screenings from corn, oats, barley and wheat), sand, molasses.
4333	The Sugarine Co., Chicago, Ill. "Sugarine Dairy Feed"	Olean	G 16.50	3.50	12.	Cottonseed meal, oats, barley, wheat, grain screenings malt sprouts, one-half of one per cent salt, molasses.
			F 17.	4.81	9.37	Cottonseed meal, malt sprouts, gluten feed, (screenings from corn, wheat, oats and barley), sand, salt, molasses.

3229	United States Sugar Feed Co., Milwaukee, Wis. "U. S. Sugar Feed"	Gouverneur	G	15.	3.	12.	Composed of cottonseed meal, wheat, corn, oats, malt sprouts, screenings, alfalfa meal and molasses.
			F	15.	3.78	8.88	Cottonseed meal, malt sprouts, small amount alfalfa meal (particles of corn, corn refuse, broken and shrunken kernels of wheat, light oats, oat refuse, and weed seeds partly ground, all apparently from screenings), broken rice, rice hulls, molasses.
4115	United States Sugar Feed Co. Milwaukee, Wis. "U. S. Sugar Feed"	East Worcester	G	15.	3.	12.	Cottonseed meal, wheat, corn, oats, malt sprouts, screenings, alfalfa meal and molasses.
			F	15.63	3.37	9.53	Cottonseed meal, malt sprouts, small amount alfalfa meal (particles of corn, corn refuse, broken and shrunken kernels of wheat, light oats, oat refuse, weed seeds partly ground and sand, all apparently from screenings), broken rice, rice hulls, ground cocoa shells, salt, molasses.
4173	United States Sugar Feed Co., Milwaukee, Wis. "U. S. Sugar Feed"	Lockport	G	15.	3.	12.	Cottonseed meal, wheat, corn, oats, malt sprouts, screenings, alfalfa meal and molasses.
			F	15.56	3.02	8.69	Cottonseed meal, malt sprouts, small amount of alfalfa meal (particles of corn, corn refuse, low grade wheat, light oats, oat refuse, weed seeds partly ground, all apparently from screenings), sand, salt, molasses.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MOLASSES FEEDS (COMPOUNDED):					
4263	United States Sugar Feed Co., Milwaukee, Wis. "U. S. Sugar Feed"	Deposit	G* 15.	3.	12.	Cottonseed meal, wheat, corn, oats, malt sprouts, screenings, alfalfa meal and molasses.
			F* 13.06	3.42	8.31	Cottonseed meal, malt sprouts, small amount of alfalfa meal (particles of corn, corn refuse, low grade wheat, light oats, oat refuse, weed seeds partly ground, all apparently from screenings), sand, salt, molasses.
4520	The Wash-Co. Alfalfa M. F. & Milling Co., Ft. Calhoun, Neb. "Wash Co. Alfalfa Horse Feed"	Nyack	G 10.	2.	12.	Corn, oats, salt and alfalfa, flavored with syrup.
			F 10.97	2.74	9.91	Alfalfa, corn, oats, molasses.
3913	Western Grain Products Co., Hammond, Ind. "Hammond Dairy Feed"	Watts Flats	G 17.	3.	11.	Cottonseed meal, distillers' grains, malt sprouts, corn, oats, barley, wheat, grain screenings and pure molasses, three-tenths of one per cent salt.
			F 15.94	3.68	9.62	Cottonseed meal, distillers' grains, malt sprouts (screenings from corn, wheat, oats, barley and flax), grit, weed seeds, mostly ground, salt and molasses.
4011	The Western Grain Products Co., Hammond, Ind. "Hammond Dairy Feed"	Pulaski	G 17.	3.	11.	Cottonseed meal, distillers' grains, malt sprouts, corn, oats, barley, wheat, grain screenings and molasses.
			F 18.75	5.16	10.52	Cottonseed meal, distillers' grains, malt sprouts, (screenings from corn, wheat, oats, barley and flax), sand, weed seeds mostly ground, salt, molasses.

4087	Western Grain Products Co., Hammond, Ind. "Hammond Dairy Feed"	Afton	G	17.	3.	11.	Cottonseed meal, distillers' grains, malt sprouts, corn, oats, barley, wheat, grain screenings and molasses.
			F	18.19	4.39	8.10	Cottonseed meal, distillers' grains, malt sprouts (screenings from corn, wheat, oats, barley, and flax, weed seeds partly ground), sand, salt, molasses.
4111	The Western Grain Products Co., Hammond, Ind. "Hammond Dairy Feed"	Richmondville	G	17.	3.	11.	Salt, cottonseed meal, distillers' grains, malt sprouts, corn, oats, barley, wheat, grain screenings, molasses.
			F	16.75	4.63	10.39	Cottonseed meal, distillers' grains, malt sprouts, (screenings from corn, wheat, barley, oats and flax, weed seeds partly ground), sand, salt, molasses.
4330	The Western Grain Products Co., Hammond, Ind. "Hammond Dairy Feed"	Olean	G	17.	3.	11.	Cottonseed meal, distillers' grains, malt sprouts, corn, oats, barley, wheat, grain screenings, and molasses, three-tenths of one per cent salt.
			F	19.	4.12	9.44	Cottonseed meal, distillers' grains, malt sprouts (screenings from corn, wheat, oats, barley and flax, weed seeds partly ground), sand, salt, molasses.
4156	W. J. Wheelock Co., Greigsville, N. Y. "Banner Dairy Feed"	Moscow	G	18.	4.	10.	Gluten, cottonseed meal, oil meal, oat clips, corn, molasses, malt sprouts, salt and distillers' grains.
			F	24.63	5.49	5.97	Gluten feed, cottonseed meal, linseed meal, corn, malt sprouts, distillers' grains (oat clippings and screenings containing a few weed seeds and grit), salt, molasses.

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ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	COTTONSEED FEEDS:†					
4445	Florida Cotton Oil Co., Jacksonville, Fla. "Durham Brand Sea Island Cotton-Seed Feed"	Truxton	G* 25. F* 25.63	6. 7.16	15. 14.85	Made from Sea Island cottonseed only. Cottonseed meal, cottonseed hulls.
4555	Southern Fibre Co., Portsmouth, Va. "Jersey Cow Feed"	Bergen	G 10. F 11.38	1.8 2.34	35. 30.35	Cottonseed hulls and cottonseed meal. As certified.
3844	Southern Fibre Co., Portsmouth, Va. "Ko-Bos Dairy Feed"	Perry	G 16. F 16.19	3.10 3.27	32. 22.82	Cottonseed meal and cottonseed hulls. As certified.
4340	Southern Fibre Co., Portsmouth, Va. "Ko-Bos Dairy Feed"	Springville	G 16. F 16.06	3.10 3.16	32. 25.47	Cottonseed meal and cottonseed hulls. As certified.
4017	Southern Fibre Co., Portsmouth, Va. "Royal Feed"	Lowville	G 22. F 24.31	4. 5.28	22. 20.90	Cottonseed meal and cottonseed hulls. As certified.
4433	Southern Fibre Co., Portsmouth, Va. "Royal Feed"	Canisteo	G 22. F 21.43	4. 4.24	22. 20.71	Cottonseed meal and cottonseed hulls. As certified.
4556	Southern Fibre Co., Portsmouth, Va. "Royal Feed"	Bergen	G 22. F 23.62	4. 4.38	22. 21.42	Cottonseed meal and cottonseed hulls. As certified.

4307	Tennessee Fibre Co., Memphis, Tenn. "Creamo Brand Cottonseed Feed"	Andover	G	22.	5.	22.	Prime cottonseed meal and cottonseed hull bran.
			F	30.56	6.27	12.58	Cottonseed meal, cottonseed hulls.
4431	Tennessee Fibre Co., Memphis, Tenn. "Creamo Brand Cottonseed Feed"	Hornell	G	22.	5.	22.	Made from choice cottonseed meal and cottonseed hull bran.
			F	21.19	4.18	18.17	Cottonseed meal, cottonseed hulls.
4490	Tennessee Fibre Co., Memphis, Tenn. "Creamo Brand Cottonseed Feed"	Deposit	G	20.	5.	22.	Choice cottonseed meal and cottonseed hull bran.
			F	23.19	5.16	17.01	Cottonseed meal, cottonseed hulls.
4543	Tennessee Fibre Co., Memphis, Tenn. "Creamo Brand Cottonseed Feed"	Sidney Centre	G	22.	5.	22.	Prime cottonseed meal and cottonseed hull bran.
			F	21.81	4.59	18.68	Cottonseed meal, cottonseed hulls.
	Poultry Foods (Compounded):						
4257	The Albert Dickinson Co., Chicago, Ill. "Queen Poultry Mash"	Corning	G	11.	2.5	10.	Corn meal, middlings, bran, shorts, alfalfa meal, beef scraps and oil cake.
			F	10.56	4.20	4.90	Corn meal, kaffir corn meal, alfalfa meal, beef scraps, linseed oil cake, corn chaff.
4338	The Albert Dickinson Co., Chicago, Ill. "Queen Poultry Mash"	Batavia	G	11.	2.5	10.	Corn meal, middlings, bran, shorts, alfalfa meal, meat scraps and oil cake.
			F	12.	4.09	6.02	Corn meal, kaffir corn, wheat bran, wheat middlings, alfalfa meal, meat scraps, linseed oil cake, corn chaff.
4358	The Albert Dickinson Co., Chicago, Ill. "Queen Poultry Mash"	Schenectady	G	11.	2.5	10.	Corn meal, middlings, bran, shorts, alfalfa meal, beef scraps, and oil cake.
			F	12.	4.04	5.29	Corn meal, kaffir corn meal, wheat bran, middlings, alfalfa meal, beef scraps, linseed oil cake.

* These letters indicate, respectively, Guaranteed and Found.
† Mixtures of cottonseed meal and cottonseed hulls.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	POULTRY FOODS (COMPOUNDED):					
4467	The Albert Dickinson Co., Chicago, Ill. "Queen Poultry Mash"	Plattsburgh	G* 11.	2.5	10.	Composed of corn meal, middlings, bran, shorts, alfalfa meal and beef scraps.
			F* 11.25	3.20	7.37	Corn meal, millet, wheat bran, middlings, alfalfa meal, meat scraps, linseed oil cake.
4036	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Poultry Meal"	Richville	G 33.	10.	——	Consisting of best qualities of beef meal, locust bean meal, sunflower seeds, cocoanut cake, albuminous compounds, iron, ginger, red pepper and a little ground shell.
			F 25.50	11.84	4.31	As certified.
4035	The Blatchford Calf Meal Factory, Waukegan, Ill. "Blatchford's Poultry Tonic"	Richville	G 33.	10.	——	Consisting of the best qualities of beef meal, sunflower seeds, cocoanut cake, albuminous compounds, iron, ginger, red pepper and a little ground shell.
			F 25.94	11.95	3.63	As certified.
4479	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Poultry Feed"	Syracuse	G 15.	4.	5.	Corn, hominy feed, wheat bran, wheat middlings, gluten feed, rolled oats.
			F 17.81	5.46	4.72	As certified.
4594	Buffalo Cereal Co., Buffalo, N. Y. "Bufceco Poultry Feed"	Buffalo	G 15.	4.	5.	Corn, hominy feed, wheat bran, wheat middlings, gluten feed, rolled oats.
			F 16.13	5.37	4.08	As certified.

4045	Buffalo Cereal Co., Buffalo, N. Y. "Poultry Feed"	Utica	G	15.	4.	5.	Made from hominy feed, wheat bran and middlings, gluten feed, rolled oats.
			F	17.69	5.75	4.31	As certified.
4126	Buffalo Cereal Co., Buffalo, N. Y. "Poultry Feed"	Oneonta	G	15.	4.	5.	Corn, hominy feed, wheat bran and middlings, gluten feed, rolled oats.
			F	15.01	5.12	3.96	As certified.
4317	Buffalo Poultry Supply Co., Buffalo, N. Y. "Buffalo Brand Laying Mash"	Buffalo	G	15.	4.	13.	Bran, middlings, corn meal, gluten meal, alfalfa, beef scraps, red dog flour, oil meal and ground oats.
			F	18.69	4.51	4.75	As certified.
4287	Geo. Craver's Sons, Binghamton, N. Y. "C. & S. Chick Food"	Binghamton	G	10.	4.20	——	
			F	11.56	2.97	2.78	Corn, wheat, millet, kaffir corn.
4041	Geo. Craver's Sons, Binghamton, N. Y. "Gold Brand Poultry Food"	Waterville	G	8.	2.	——	
			F	11.25	3.40	2.58	Cracked corn, wheat, buckwheat, millet, kaffir corn, sunflower seed.
4272	Geo. Craver's Sons, Binghamton, N. Y. "Gold Brand Poultry Food"	Mt. Upton	G	8.	2.	——	
			F	11.56	3.32	2.60	Kaffir corn, millet, barley, oats, cracked corn, wheat, sunflower seeds.
4311	Cyphers Incubator Co., Buffalo, N. Y. "Cyphers Forcing Food"	Buffalo	G	11.	3.	5.	Kaffir meal, bran, red dog, shorts, corn meal, alfalfa meal.
			F	11.75	4.04	2.25	Wheat bran, wheat shorts, corn meal, kaffir corn meal, red dog flour, alfalfa meal, salt.
4312	Cyphers Incubator Co., Buffalo, N. Y. "Cyphers Laying Food"	Buffalo	G	15.	3.	6.	Kaffir meal, bran, red dog, shorts, corn meal, alfalfa meal, blood meal.
			F	15.	4.04	2.96	Kaffir meal, wheat bran, wheat middlings, red dog flour, corn meal, alfalfa meal, blood meal, salt.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	POULTRY FOODS (COMPOUNDED):					
4607	Cyphers Incubator Co., Buffalo, N. Y. "Forcing Food"	Bedford Hills	G* 12.3 F* 12.	4.1 3.70	—— 2.44	Corn meal, wheat bran, wheat middlings, weed seeds partly ground.
4521	Cyphers Incubator Co., Buffalo, N. Y. "Laying Food"	Nyack	G 15. F 17.50	3. 4.10	6. 5.68	Kaffir meal, wheat bran, wheat middlings, corn meal, alfalfa meal, red dog flour, blood meal.
4067	R. D. Eaton Grain & Feed Co., Norwich, N. Y. "Eaton's Perfection Mash Mixture for Laying Fowls"	Norwich	G 20.	4.	8.	Alfalfa meal, milk albumen, milo maize meal, beef scrap, charcoal, winter wheat bran, kaffir corn meal, granulated bone, whole wheat flour, linseed oil meal, gluten, pea meal, bone flour, ground oats, hen-e-ta grits, sodium chloride.
			F 20.43	4.58	7.60	As certified.
4240	R. D. Eaton Grain & Feed Co., Norwich, N. Y. "Eaton's Perfection Mash Mixture for Laying Fowls"	Middletown	G 20.	4.	8.	Alfalfa meal, milo maize meal, milk albumen, beef scrap, charcoal, winter wheat bran, kaffir corn meal, granulated bone, whole wheat flour, linseed oil meal, gluten, pea meal, bone flour, sodium chloride, ground oats, hen-e-ta grits.
			F 18.38	4.67	7.31	As certified.

4342	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Laying Mash"	Buffalo	G	15.	4.	10.	Wheat bran, wheat middlings, wheat flour, ground oats, corn meal, gluten meal, ground alfalfa, oil meal, beef scrap.
			F	16.44	4.79	8.25	Wheat bran, wheat middlings, wheat flour, ground oats, corn meal, alfalfa meal, linseed meal, meat scraps, kaffir corn, salt.
4154	Harvey Seed Co., Buffalo, N. Y. "Electric Poultry Food"	Silver Springs	G	12.	3.	——	Corn meal, middlings, gluten feed, cottonseed meal, bran, oil meal.
			F	14.19	4.61	3.46	Corn meal, wheat middlings, gluten feed, cottonseed meal.
3837	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Scratching Feed"	Buffalo	G	11.	3.50	9.	Wheat, oats, kaffir corn, buckwheat, mixed broken grains, cracked corn, milo maize, sunflower seed, hulled oats.
			F	11.50	3.10	1.60	As certified.
4057	The H-O Co., Buffalo, N. Y. "The H-O Co's Algrane Scratching Feed"	Syracuse	G	11.	3.50	9.	Wheat, wheat screenings, oats, cracked corn, kaffir corn, milo maize, buckwheat, sunflower seed, hulled oats.
			F	11.19	3.38	1.86	As certified.
3836	The H-O Co., Buffalo, N. Y. "The H-O Co's Chick Feed"	Buffalo	G	12.	3.	9.	Corn, cut oat meal, cracked wheat, kaffir corn, peas, millet.
			F	12.	2.67	1.74	As certified.
4058	The H-O Co., Buffalo, N. Y. "The H-O Co's Chick Feed"	Syracuse	G	12.	3.	9.	Corn, cut oat meal, cracked wheat, kaffir corn, peas, millet.
			F	12.25	2.94	1.66	As certified.
4346	The H-O Co., Buffalo, N. Y. "The H-O Co's Dry Poultry Mash"	Buffalo	G	20.	3.50	9.	Oat middlings, gluten feed, wheat middlings, rolled oats, alfalfa, corn, hominy feed, cracked wheat, wheat bran.
			F	14.31	3.85	9.55	As certified.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	POULTRY FOODS (COMPOUNDED):					
4360	The H-O Co., Buffalo, N. Y. "The H-O Co's Dry Poultry Mash"	Schenectady	G* 20.	3.50	9.	Oat middlings, gluten feed, wheat middlings, rolled oats, alfalfa, corn, hominy feed, cracked wheat, wheat bran.
			F* 15.31	4.18	9.45	As certified.
4347	The H-O Co., Buffalo, N. Y. "The H-O Co's Poultry Feed"	Buffalo	G 17.	5.50	9.	Oat middlings, gluten feed, wheat middlings, rolled oats, wheat bran, hominy feed.
			F 18.69	4.93	5.85	As certified.
4359	The H-O Co., Buffalo, N. Y. "The H-O Co's Poultry Feed"	Schenectady	G 17.	5.50	9.	Oat middlings, rolled oats, gluten, wheat bran, wheat middlings, hominy feed.
			F 18.44	5.26	6.13	As certified.
4074	The H-O Co., Buffalo, N. Y. "The H-O Co's Poultry Feed"	Canastota	G 17.	5.50	9.	Oat middlings, gluten, wheat middlings, rolled oats, wheat bran, hominy feed.
			F 18.25	5.49	5.06	As certified.
3240	Husted Milling Co., Buffalo, N. Y. "Husted Laying Mash"	Watertown	G 15.	3.	8.	Bran, middlings, corn, rolled oats, cottonseed meal.
			F 17.82	5.15	4.78	Wheat bran, wheat middlings, corn, rolled oats, cottonseed meal, pea meal.
4276	Husted Milling Co., Buffalo, N. Y. "Husted Laying Mash"	New Berlin	G 15.	3.	8.	Bran, middlings, corn, rolled oats, cottonseed meal.
			F 18.56	5.14	5.09	Wheat bran, wheat middlings, corn, rolled oats, cottonseed meal, pea meal.

4567	Husted Milling Co., Buffalo, N. Y. "Husted Laying Mash"	Buffalo	G	15.	3.	8.	Bran, middlings, corn, rolled oats, cottonseed meal.
			F	17.56	5.64	4.29	Wheat bran, wheat middlings, corn, rolled oats, cottonseed meal, pea meal, gluten feed, salt.
4603	Husted Milling Co., Buffalo, N. Y. "Husted Laying Mash"	Ossining	G	15.	3.	8.	Bran, middlings, corn, rolled oats, cottonseed meal.
			F	17.56	5.13	4.35	Wheat bran, wheat middlings, corn, rolled oats, cottonseed meal, pea meal, gluten feed, salt.
3996	Husted Milling Co., Buffalo, N. Y. "Husted Poultry Feed"	Auburn	G	12.	4.	9.	Bran, middlings, corn, gluten, alfalfa.
			F	15.04	4.78	5.81	Corn meal, wheat bran, alfalfa.
4231	Husted Milling Co., Buffalo, N. Y. "Husted Poultry Feed"	Monroe	G	12.	4.	9.	Bran, middlings, corn, gluten, alfalfa.
			F	15.81	4.74	6.77	Corn meal, wheat bran, alfalfa.
4568	Husted Milling Co., Buffalo, N. Y. "Husted Poultry Feed"	Buffalo	G	12.	4.	9.	Bran, middlings, corn, gluten, alfalfa.
			F	15.63	5.12	7.78	Wheat bran, wheat middlings, corn, gluten feed, alfalfa, salt.
4583	E. H. Kern, Buffalo, N. Y. "Dry Mash"	Buffalo	G	——	——	——	Oil meal, alfalfa, charcoal, corn meal, middlings.
			F	11.25	2.70	9.85	Linseed meal, alfalfa, charcoal, cracked corn, wheat bran, wheat middlings, oats, oat hulls, grit.
4587	Model Milling Co., Buffalo, N. Y. "Model Egg Mash"	Buffalo	G	18.	4.50	6.	Corn meal, wheat meal, gluten, pea meal, middlings, oil meal, cottonseed meal, malt sprouts, alfalfa meal, animal meal, salt.
			F	17.50	3.54	7.06	Corn meal, wheat bran, wheat middlings, gluten feed, pea meal, cottonseed meal, malt sprouts, alfalfa meal, animal meal, corn offal.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	POULTRY FOODS (COMPOUNDED):					
4588	Model Milling Co., Buffalo, N. Y. "Model Growing Food"	Buffalo	G* 11.	3.	2.50	Corn, wheat, millet, peas, kafir, milo maize, animal meal.
			F* 16.06	4.04	8.52	Corn, wheat bran, wheat middlings, alfalfa meal, cottonseed meal, gluten feed, pea meal, millet, animal meal.
4403	Mystic Milling & Feed Co., Rochester, N. Y. "Puritan Laying Mash"	Rochester	G 23.	7.	8.	Gluten, oil. meal, bran, corn meal, middlings, alfalfa meal, bone meal, meat meal.
			F 27.54	4.28	7.02	Gluten feed, linseed meal, wheat bran, corn meal, wheat middlings, alfalfa meal, bone meal, meat meal, pea meal, kaffir corn.
4529	Mystic Milling & Feed Co., Rochester, N. Y. "Puritan Laying Mash"	Port Chester	G 23.	7.	8.	Gluten, oil meal, bran, corn meal, middlings, alfalfa meal, bone meal, meat meal.
			F 26.50	4.40	6.29	Gluten feed, linseed meal, wheat bran, wheat middlings, corn meal, alfalfa meal, bone and meat meal, kaffir meal, pea meal.
4315	A. Nowak & Son, Buffalo, N. Y. "Lay Egg-O Poultry Dry Mash"	Buffalo	G 12.	3.	5.	Corn, gluten feed, wheat bran, wheat middlings, and Heneta crystal grits.
			F 14.13	3.16	3.58	As certified.
4434	A. Nowak & Son, Buffalo, N. Y. Lay Egg-O Poultry Dry Mash"	Corning	G 12.	3.	5.	Corn, gluten feed, wheat bran, wheat middlings and Heneta crystal grits.
			F 13.94	3.23	3.71	As certified.

4574	A. Nowak & Son, Buffalo, N. Y. "Lay Egg-O Poultry Dry Mash"	Buffalo	G	12.	3.	5.	Corn, gluten feed, wheat bran, wheat middlings and Heneta crystal grits.
			F	14.81	3.10	4.41	As certified.
4210	The Park & Pollard Co., Boston, Mass. "Dry Mash Feed"	Saratoga	G	20.	3.	——	Bran, middlings, corn, wheat, barley, alfalfa, fish, meat, bone and salt.
			F	19.63	4.21	7.47	Corn, wheat, wheat bran, alfalfa, hominy feed, meat scraps, oat middlings, oat hulls.
4419	The Park & Pollard Co., Boston, Mass. "Dry Mash"	Syracuse	G	20.	3.	10.	Bran, middlings, corn, wheat, barley, alfalfa, fish, meat, bone and salt.
			F	16.69	4.17	8.93	Wheat bran, wheat middlings, corn, wheat, barley, alfalfa, fish, meat, bone, oat hulls, screenings containing weed seeds mostly ground, salt.
4462	The Park & Pollard Co., Boston, Mass. "Dry Mash Feed"	Tupper Lake	G	20.	3.	10.	Bran, middlings, corn, wheat, barley, alfalfa, fish, meat, bone and salt.
			F	19.	4.81	5.97	Wheat bran, wheat middlings, corn, wheat, barley, alfalfa, fish, meat, bone screenings containing weed seeds mostly ground, oat hulls, salt.
4374	The Park & Pollard Co., Boston, Mass. "Growing Feed"	Poughkeepsie	G	14.	3.12	——	Bran, middlings, corn, wheat, barley, alfalfa, fish, meat, bone and salt.
			F	15.88	5.33	4.56	Corn, wheat, wheat middlings, oats, oat middlings, oat hulls, barley, ground meat, salt, screenings.
4418	The Park & Pollard Co., Boston, Mass. "Growing Feed"	Syracuse	G	10.	3.50	5.	Bran, middlings, corn, wheat, barley, alfalfa, fish, meat, bone and salt.
			F	13.37	4.06	4.91	Wheat bran, wheat middlings, corn, wheat, oats, barley, alfalfa, fish, meat, bone, oat hulls, ground screenings, salt.

* These letters indicate, respectively, Guaranteed and Found

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	POULTRY FOODS (COMPOUNDED):					
4553	The Park & Pollard Co., Boston, Mass. "Growing Feed"	Buffalo	G* 10.	3.50	5.	Bran, middlings, corn, wheat, barley, alfalfa, fish, meat, bone and salt.
			F* 19.	4.39	7.77	Wheat bran, wheat middlings, corn, wheat, barley, alfalfa, fish, meat, bone, screenings containing weed seeds mostly ground, oat hulls, salt.
4399	Purina Mills, St. Louis, Mo. "Purina Chicken Chowder"	Kingston	G 16.	2.5	9.	Alfalfa meal, corn meal, bran, middlings, charcoal, linseed meal, granulated meat.
			F 17.88	3.93	6.35	Alfalfa meal, corn meal, wheat bran, wheat middlings, charcoal, linseed meal, ground meat, salt.
4401	Purina Mills, St. Louis, Mo. "Purina Chicken Chowder"	Rochester	G 16.	2.5	11.5	Alfalfa meal, corn meal, bran, middlings, charcoal, linseed meal, granulated meat, bone meal.
			F 18.69	4.35	8.61	Alfalfa meal, corn meal, wheat bran, wheat middlings, charcoal, linseed meal, ground meat and bone, salt.
4494	Purina Mills, St. Louis, Mo. "Purina Chicken Chowder Feed"	Binghamton	G 16.	2.5	9.	Alfalfa meal, corn meal, bran, middlings, charcoal, granulated meat, linseed meal.
			F 18.75	4.65	7.66	Alfalfa meal, corn meal, wheat bran, wheat middlings, charcoal, ground meat, linseed meal, salt.

3999	Puritan-American Poultry Food Mfg. Co., Bound Brook, N. J. "Puritan Chick Food"	Auburn	G	12.5	7.	6.	Corn, wheat, meat, oyster shell, sulphur, anise seed, charcoal and fenugreek.
			F	13.03	6.27	3.62	As certified.
4100	The Quaker Oats Co., Chicago, Ill. "American Poultry Feed"	Elmira	G	12.	3.50	9.	Corn, barley, cottonseed meal, wheat bran.
			F	14.43	5.65	3.21	As certified.
4536	The Quaker Oats Co., Chicago, Ill. "American Poultry Feed"	White Plains	G	12.	3.50	9.	Corn, barley, cottonseed meal, and wheat bran.
			F	13.69	4.12	4.04	As certified.
4318	The Quaker Oats Co., Chicago, Ill. "Schumacher Little Chick Feed with Grit"	Fillmore	G	10.	2.50	5.	Corn, rye, millet, kaffir corn and wheat, six per cent marble grit, one-half of one per cent poultry charcoal.
			F	10.81	2.95	1.98	Cracked corn, cracked kaffir corn, millet, rye, shrunken and broken wheat, grit, charcoal, charlock, wild sunflower seed, green foxtail, lambs quarters.
4253	Fred Smith, Elmira, N. Y. "Cornell Mash"	Elmira	G	——	——	——	Middlings, C meal, alfalfa, meat scrap, oil meal, bran.
			F	20.37	5.26	6.25	Alfalfa, wheat bran, wheat middlings, corn meal, meat scraps, linseed meal.
4254	Fred Smith, Elmira, N. Y. "Hen-O-La Mash Food"	Elmira	G	——	——	——	Corn meal, gluten feed (23 per cent protein), wheat middlings, wheat bran, pea meal, (or old process oil meal), superfine "Hen-e-ta" (No. 4), No. 1 "Hen-e-ta."
			F	12.31	3.15	3.68	As certified.
4499	Tioga Mill & Elevator Co., Waverly, N. Y. "Keystone Dry Mash"	South New Berlin	G	——	——	——	
			F	13.50	3.20	3.06	Wheat bran, wheat middlings, corn meal, linseed meal, Heneta grit, gluten feed.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
				Per ct.	*Per ct.*	*Per ct.*	
	POULTRY FOODS (COMPOUNDED):						
4540	Tioga Mill & Elevator Co., Waverly, N. Y. "Keystone Dry Mash"	Watervliet	G*	14.55	3.72	14.66	Alfalfa meal, wheat bran, wheat middlings, corn meal, ground oats, old process oil meal.
			F*	15.13	3.86	10.46	As *certified*.
3823	The Van Iderstine Co., Long Island City, N. Y. "Darling's Mash Food for Poultry"	Long Island City	G	18.	3.50	10.	Corn, beef, blood, bone, alfalfa, middlings, bran, oyster shells, grit.
			F	17.	4.18	4.96	As certified.
4226	L. R. Wallace, Middletown, N. Y. "Mapes' Balanced Ration"	Florida	G	12.	4.	8.	Animal meal, ground bone, corn meal, middlings, bran, gluten, ground oats.
			F	12.63	4.81	3.49	Animal meal, corn meal, wheat middlings, wheat bran, gluten feed, corn offal, ground oats.
	ANIMAL FOODS:						
4539	Albany Rendering Co., Albany, N. Y. "Albany Bone & Meat Meal for Poultry"	Troy	G	35.	8.	——	
			F	39.19	12.36	——	Animal meal. Contains small amount of bone.
4387	Albany Rendering Co., Albany, N. Y. "Albany Cooked Meat Scraps for Poultry"	Albany	G	40.	8.	——	
			F	38.	12.67	——	Meat scraps. Contains considerable bone.
4604	The Berg Co., Philadelphia, Pa. "3 Medal Poultry Meat"	Ossining	G	50.	13.	3.	
			F	51.31	10.41	——	Meat scraps. Contains considerable bone.

4030	The Bowker Fertilizer Co., New York, N. Y. "Bowker's Animal Meal for Fowls and Chickens"	Malone	G F	40. 39.88	5. 6.54	15. ——	Animal meal, contains meat, blood and a large amount of bone.
4060	The Bowker Fertilizer Co., New York, N. Y. "Bowker's Animal Meal for Fowls and Chicks"	Syracuse	G F	40. 40.38	5. 5.62	15. ——	Meat and bone. Meat and bone meal.
4302	Bowker Fertilizer Co., New York, N. Y. "Bowker's Animal Meal for Fowls and Chicks"	Buffalo	G F	40. 45.06	5. 5.50	15. ——	Thoroughly cooked meat and bone. As certified.
4364	The Bowker Fertilizer Co., New York, N. Y. "Bowker's Animal Meal"	Chatham	G F	40. 42.06	5. 13.05	15. ——	Animal meal.
4295	H. F. Brehm, Waterloo, N. Y. "Brehm's Beef Scrap"	Geneva	G F	40. 39.06	15. 21.34	—— ——	Meat scraps. Contains considerable bone.
4471	Burlington Rendering Co., Burlington, Vt. "Bone and Meat Meal"	Chase Mills	G F	35. 31.88	8. 11.56	—— ——	As branded.
4470	Burlington Rendering Co., Burlington, Vt. "Burlington Cooked Meat Scraps for Poultry"	Champlain	G F	40. 40.31	8. 11.88	—— ——	Meat scraps. Contains considerable bone.
4271	Cyphers Incubator Co., Buffalo, N. Y. "High Protein Beef Scrap for Poultry"	Oxford	G F	45. 48.06	10. 12.96	—— ——	Meat scraps. Contains a medium amount of bone.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	ANIMAL FOODS:					
4301	Darling & Co., Chicago, Ill. "Darling's Pure Ground Beef Scraps for Poultry"	Buffalo	G* 55. F* 52.	10. 10.14	2.50 —	Meat scraps. Contains small amount of bone.
4409	Darling & Co., Chicago, Ill. "Darling's Pure Ground Beef Scraps for Poultry"	Chenango Forks	G 55. F 56.38	10. 11.09	2.50 —	Meat scraps. Contains small amount of bone.
4063	R. D. Eaton Grain & Feed Co., Norwich, N. Y. "Eaton's High Grade Beef Scrap"	Norwich	G 50. F 57.25	8. 12.92	— —	Meat scraps. Contains considerable bone.
4260	The Economy Meat Food Co., Buffalo, N. Y. "Economy Beef Scrap"	Hornell	G 65. F 57.44	10. 9.28	— —	Meat scraps. Contains small amount of bone.
4046	Geo. M. Finn, Syracuse, N. Y. "Ground Beef and Bone Scrap Chicken Feed"	Utica	G 35. F 42.06	15. 24.09	— —	Meat scraps. Contains considerable bone.
4059	George M. Finn, Syracuse, N. Y. "Ground Beef and Bone Scrap Chicken Feed"	Syracuse	G 35. F 41.50	15. 22.10	— —	Meat scraps. Contains considerable bone.

4092	The Flavell Co., Asbury Park, N. J. "Pure Beef Cracklings"	Groton	G F	50. 51.01	15. 16.15	—— ——	Meat scraps. Contains considerable bone.
4208	The Flavell Co., Asbury Park, N. J. "Pure Beef Cracklings"	Glens Falls	G F	50. 50.63	15. 14.87	—— ——	Meat scraps. Contains considerable bone.
3244	The L. T. Frisbie Co., New Haven, Conn. "Frisbie's Cooked Meat Scraps for Poultry"	Canton	G F	40. 44.10	8. 11.56	—— ——	
4394	The L. T. Frisbie Co., New Haven, Conn. "Frisbie's Cooked Meat Scraps for Poultry"	Catskill	G F	40. 47.69	8. 10.84	—— ——	Meat scraps. Medium amount of bone.
4316	Globe Elevator Co., Buffalo, N. Y. "Blue Ribbon Beef Scrap for Poultry"	Buffalo	G F	50. 59.69	6. 9.12	—— ——	Meat scraps. Contains considerable bone.
4039	Geo. L. Harding, Binghamton, N. Y. "Harding's Uncle Sam Beef Scraps"	Waterville	G F	40. 40.19	15. 13.36	—— ——	Beef scraps. Contains considerable bone.
4088	C. P. Matthews & Sons Scranton, Pa. "Keystone Beef Scrap"	Afton	G F	40. 46.38	10. 10.28	—— ——	Meat scraps. Contains a medium amount of bone.
4485	Model Milling Co., Buffalo, N. Y. "Model Beef Scrap"	Auburn	G F	50. 56.13	6. 8.45	—— ——	Meat scraps. Contains small amount of bone.
4388	L. Newhof & Son, Albany, N. Y. "Poultry Food"	Albany	G F	50. 37.25	16. 11.73	—— ——	Animal meal. Contains small amount of bone.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	ANIMAL FOODS:					
4420	The Park & Pollard Co., Boston, Mass. "Blue Ribbon Meat Scraps"	Syracuse	G* 50. F* 52.44	10. 13.73	—— ——	Meat scraps. Contains considerable bone.
4027	The Park & Pollard Co., Boston, Mass. "Blue Ribbon Meat Scraps Special"	Malone	G 50. F 58.19	10. 13.15	—— ——	Beef scraps. Contains a considerable amount of bone.
4077	The Park & Pollard Co., Boston, Mass. "Fine Screened Meat Scraps"	Syracuse	G 35. F 43.25	15. 17.72	—— ——	Meat scraps. Contains considerable bone.
4355	The Park & Pollard Co., Boston, Mass. "Screened Meat Scraps"	Kingston	G 35. F 43.05	15. 16.32	—— ——	Meat scraps. Contains considerable bone.
3230	D. W. Romaine, Jersey City, N. J. "D. W. Romaine's Evaporated Boiled Beef and Bone for Poultry"	Brownville	G 50. F 41.63	17.85 18.45	1.80 ——	Fresh meat and sheepheads boiled, dried and ground into powder. As certified.
4513	D. W. Romaine, Jersey City, N. J. "D. W. Romaine's Evaporated Boiled Beef and Bone"	Nanuet	G 50. F 52.25	17.85 14.91	1.80 ——	Fresh meat and sheepheads boiled, dried and ground into meal. As certified.
4522	M. L. Shoemaker & Co., Ltd., Philadelphia, Pa. "Ground Beef Scraps"	Port Chester	G 55. F 56.81	10. 13.18	—— ——	Meat scraps. Contains considerable bone.

4523	Spratt's Patent (America) Ltd., Newark, N. J. "Spratt's Patent Ground Meat"	Port Chester	G F	43. 52.50	11. 14.58	2. ——	Meat scraps. Contains considerable bone.
4361	H. M. Stanton, Schenectady, N. Y. "Ground Beef Scraps"	Schenectady	G F	40. 41.06	15. 25.37	—— ——	Meat scraps. Contains considerable bone.
3821	Stumpp & Walter Co., New York, N. Y. "Quality Kind Beef Scrap"	New York	G F	50. 55.19	10. 13.75	—— ——	Meat scraps. Contains considerable bone.
4220	Swift & Co., Newark, N. J. "Swift's Beef Scrap"	Goshen	G F	50. 57.13	10. 12.24	—— ——	Meat scraps. Contains medium amount of bone.
4251	Swift & Co., Newark, N. J. "Swift's Beef Scrap"	Elmira	G F	50. 54.25	10. 12.10	—— ——	Meat scraps. Contains considerable bone.
4252	Swift & Co., Newark, N. J. "Swift's Meat Meal"	Elmira	G F	46. 47.06	—— 7.90	—— ——	Animal meal. Contains considerable bone.
4129	Swift's Lowell Fertilizer Co., Boston, Mass. "Swift's Lowell Bone and Meat Meal for Poultry"	Oneonta	G F	35. 40.69	8. 8.66	—— ——	Animal meal. Contains a very small amount of bone.
4428	Swift's Lowell Fertilizer Co., Boston, Mass. "Swift's Lowell Bone and Meat Meal for Poultry"	Lestershire	G F	35. 42.13	8. 13.41	—— ——	Animal meal. Small amount of bone.
4127	Swift's Lowell Fertilizer Co., Boston, Mass. "Swift's Lowell Cooked Meat Scraps for Poultry"	Oneonta	G F	40. 42.10	8. 9.74	—— ——	Meat scraps. Contains considerable bone.

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ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	ANIMAL FOODS:					
4085	Swift's Lowell Fertilizer Co., Boston, Mass. "Swift's Lowell Meat Scraps for Poultry"	Afton	G* 40. F* 43.44	8. 13.30	—— ——	Meat scraps. Contains considerable bone.
4443	Swift's Lowell Fertilizer Co., Boston, Mass. "Swift's Lowell Poultry Food"	Whitney Point	G 40. F 41.94	8. 12.50	—— ——	Prepared from cooked meat scraps. Meat scraps. Contains considerable bone.
3915	Syracuse Rendering Co., Syracuse, N. Y. "Bone and Meat Meal for Poultry"	Batavia	G 35. F 41.	8. 10.67	—— ——	Meat meal.
4062	Syracuse Rendering Co., Syracuse, N. Y. "Bone and Meat Meal"	Norwich	G 35. F 37.19	8. 9.35	—— ——	Meat and bone meal.
4186	Syracuse Rendering Co., Syracuse, N. Y. "Syracuse Bone and Meat Meal for Poultry"	Portageville	G 35. P 44.13	8. 10.33	—— ——	Animal meal. Contains considerable bone.
3960	Syracuse Rendering Co., Syracuse, N. Y. "Syracuse Cooked Meat Scraps for Poultry"	Greene	G 40. F 42.72	8. 14.16	—— ——	

3226	Syracuse Rendering Co., Syracuse, N. Y. "Syracuse Cooked Meat Scraps for Poultry"	Ogdensburg	G	40.	8.	——	
			F	41.69	13.57	——	
4495	Syracuse Rendering Co., Syracuse, N. Y. "Syracuse Poultry Food"	Binghamton	G	40.	8.	——	Prepared from cooked meat scraps.
			F	42.94	13.52	——	Meat scraps. Contains a medium amount of bone.
3826	The Van Iderstine Co., Long Island City, N. Y. "Darling's Blood Meal for Poultry"	Long Island City	G	80.	——	——	
			F	84.38	.52	——	Dried blood.
4478	The Van Iderstine Co., Long Island City, N. Y. "Darling's Blood Meal for Poultry"	Syracuse	G	80.	——	——	
			F	85.25	——	——	Dried blood.
3825	The Van Iderstine Co., Long Island City, N. Y. "Darling's Digester Tankage for Hogs"	Long Island City	G	40.	——	——	
			F	39.94	14.69	——	Animal meal.
3824	The Van Iderstine Co., Long Island City, N. Y. "Darling's Digester Tankage for Hogs"	Long Island City	G	60.	——	——	
			F	65.25	8.45	——	Animal meal.
4441	The Van Iderstine Co. Long Island City, N. Y. "Darling's Digester Tankage for Poultry"	Greene	G	60.	——	——	
			F	63.25	9.78	——	Animal meal.
3822	The Van Iderstine Co., Long Island City, N. Y. "Darling's Pure Ground Beef Meal for Poultry"	Long Island City	G	45.	10.	3.	
			F	48.25	12.76	——	Animal meal.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	ANIMAL FOODS:					
3995	The Van Iderstine Co., Long Island City, N. Y. "Darling's Pure Ground Beef Scraps for Poultry"	Auburn	G* 55. F* 59.81	5. 11.43	3. ——	Beef scraps. Contains considerable bone.
4458	The Van Iderstine Co., Long Island City, N. Y. "Darling's Pure Ground Beef Scraps for Poultry"	Clinton	G 55. F 56.38	10. 14.11	3. ——	Meat scraps. Contains small amount of bone.
4501	The Van Iderstine Co., Long Island City, N. Y. "Darling's Pure Ground Beef Scraps for Poultry"	Newburgh	G 55. F 58.63	10. 13.07	3. ——	Meat scraps. Contains considerable bone.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	ALFALFA MEALS:				
4005	The Albert Dickinson Co., Chicago, Ill. "Alfalfa Meal"	Rome	G* 12. F* 12.74	1. 1.44	35. 32.22
4061	The Albert Dickinson Co., Chicago, Ill. "Alfalfa Meal"	Syracuse	G 12. F 13.19	1. 1.96	35. 27.97
4170	The Albert Dickinson Co., Chicago, Ill. "Alfalfa Meal"	Albion	G 12. F 14.88	1. 1.64	35. 28.65
3829	American Alfalfa Food Co., Wichita, Kan. "Acme Alfalfa Meal"	Salamanca	G 14. F 15.43	1.92 2.41	25. 26.
4042	American Milling Co., Chicago, Ill. "Amco Alfalfa Meal"	Waterville	G 13. F 13.81	2. 1.55	25. 29.15
4489	American Milling Co., Chicago, Ill. "Amco Alfalfa Meal"	Oxford	G 13. F 14.68	2. 1.48	25. 30.99
4324	American Alfalfa Milling Co., Kansas City, Mo. "American Alfalfa Meal"	Cuba	G 13. F 16.87	1.25 2.08	30. 25.86
4487	American Alfalfa Milling Co., Kansas City, Mo. "American Alfalfa Meal"	Auburn	G 13. F 15.19	1.25 1.66	30. 29.19
4393	Clarence S. Briggs, Fowler, Colo. "Briggs' Pure Alfalfa Meal"	Ravena	G 12. F 15.	1.50 1.42	34. 29.79
4404	Clarence S. Briggs, Fowler, Colo. "Briggs' Pure Alfalfa Meal"	Rochester	G 12. F 12.81	1.50 1.73	34. 30.61
4493	The Colorado Alfalfa Milling Co., Boulder, Colo. "Alfalfa Meal"	Binghamton	G 12. F 14.75	2.50 1.49	30. 29.31
4606	The Corno Mills Co., St. Louis, Mo. "Corno Alfalfa Meal"	Yonkers	G 15. F 14.94	1.50 1.49	29. 26.43

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.
				Per ct.	*Per ct.*	*Per ct.*
	ALFALFA MEALS:					
3845	Cyphers Incubator Co., Buffalo, N. Y. "Mealed Alfalfa"	Salamanca	G* F*	—— 14.31	—— 1.52	—— 28.37
4313	Cyphers Incubator Co., Buffalo, N. Y. "Cyphers Mealed Alfalfa"	Buffalo	G F	17. 22.63	2. 3.24	19. 12.99
4517	Deposit Milling Co., Deposit, N. Y. "Alfalfa Meal"	Spring Valley	G F	11. 14.43	2. 1.54	35. 32.59
4026	Kemper Mill & Elevator Co., Kansas City, Mo. "Choice Colorado Alfalfa Meal"	Malone	G F	13.50 14.	1.25 1.58	30. 29.18
4299	Kemper Mill & Elevator Co., Kansas City, Mo. "Choice Colorado Alfalfa Meal"	Rochester	G F	13.50 15.43	1.25 1.46	30. 27.25
4408	Kornfalfa Feed Milling Co., Kansas City, Mo. "Pioneer Alfalfa Meal"	Binghamton	G F	12. 14.19	1.50 1.79	30. 30.33
4542	Kornfalfa Feed Milling Co., Kansas City, Mo. "Pioneer Alfalfa Meal"	Middleburgh	G F	13. 14.	1. 2.14	35. 30.17
4610	Chas. A. Krause Milling Co., Milwaukee, Wis. "Alfalfa Meal"	Hoosick Falls	G F	14. 18.56	1. 1.99	30. 20.41
4525	The Frank S. Platt Co., New Haven, Conn. "Alfalfa Meal"	Port Chester	G F	—— 15.13	—— 1.62	—— 28.71
4518	J. C. Smith & Wallace Co., Newark, N. J. "Alfalfa Meal"	Suffern	G F	—— 17.50	—— 2.18	—— 24.22
4097	Tioga Mill & Elevator Co., Waverly, N. Y. "Alfalfa Meal"	Guilford Centre	G F	14.15 14.25	1.63 1.64	31.09 26.43
3830	The Traders & Producers Supply Co., Buffalo, N. Y. "Alfalfa Meal"	Salamanca	G F	—— 16.	—— 2.27	—— 25.45

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.
			Per ct.	*Per ct.*	*Per ct.*
	ALFALFA MEALS:				
4519	The Van Iderstine Co., Long Island City, N. Y. "Darling's Alfalfa Meal for Poultry"	Monsey	G* 14. F* 16.62	1. 1.76	40. 24.36
4532	The Otto Weiss Alfalfa Stock Food Co., Wichita, Kan. "Pure Dustless Alfalfa"	Mount Vernon	G —— F 15.19	—— 1.94	—— 29.79
4592	The Otto Weiss Alfalfa Stock Food Co., Wichita, Kan. "Pure Dustless Alfalfa"	Buffalo	G 14. F 16.31	1.50 2.54	30. 25.58

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	BEET SUGAR RESIDUES:					
3957	The Larrowe Milling Co., Detroit, Mich. "Dried Beet Pulp"	Binghamton	G* 8. F* 8.88	.50 .73	20. 18.53	Residue of sugar beets dried after extraction of sugar. As certified.
4120	Michigan Sugar Co., Sebewaing, Mich. "Dried Beet Pulp"	Worcester	G 8. F 8.28	.50 .74	20. 17.50	Residue of sugar beets dried after extraction of sugar.
4117	Owosso Sugar Co., Owosso, Mich. "Dried Beet Pulp"	Worcester	G 8. F 9.44	.50 .78	20. 18.59	Residue of sugar beets dried after extraction of sugar.
	MISCELLANEOUS FEEDS:					
4083	Acme-Evans Co., Indianapolis, Ind. "Hoosier Mill Feed"	Homer	G 16.50 F 17.75	4. 4.98	9. 6.87	Wheat bran, wheat middlings, ground wheat screenings mill's run. As certified.
4488	Acme-Evans Co., Indianapolis, Ind. "Acme Feed"	Norwich	G 16.50 F 17.13	4. 5.07	9. 7.74	Wheat bran, wheat middlings, ground wheat screenings. Wheat bran, wheat middlings.
4496	American Cattle & Poultry Food Co., Binghamton, N. Y. "Sunlight Fancy Mixed Feed"	Binghamton	G 15.3 F 17.06	4.4 4.65	11.1 6.71	Bran and middlings. Wheat bran, wheat middlings.
4412	Allen V. Smith, Marcellus Falls, N. Y. "Barley Feed"	Marcellus Falls	G 13. F 18.19	3. 4.67	12. 5.71	

4352	M. F. Baringer, Philadelphia, Pa. " Pure Corn Bran "	Pine Bush	G F	7. 7.69	5. 3.98	15. 12.	By-product of the milling of corn, consisting of corn bran, particles of corn, the ends of the corn kernel, glumes, and a small amount of corn offal.
4181	The Cleveland Seed Co., Avon, N. Y. " Pea Meal "	Avon	G F	20. 17.75	1.80 1.31	15. 23.69	
4375	Duluth-Superior Milling Co., Duluth, Minn. " Boston Mixed Feed "	Poughkeepsie	G F	16. 17.13	4.50 5.49	8.50 6.63	Wheat bran, middlings and low grade flour. As certified.
4586	Galbraith Milling Co., Mount Morris, N. Y. " Bran "	Geneseo	G F	—— 16.88	—— 5.28	—— 6.36	Wheat bran, small amount of wheat middlings, small amount of corn meal.
3841	General Flour & Feed Co., Buffalo, N. Y. " Buffalo Meal "	Clarendon	G F	7. 8.69	3. 3.72	7. 2.61	Corn and cob meal, the amount of cob used being the same as though ear corn was ground cob and all. As certified.
4052	General Flour & Feed Co., Buffalo, N. Y. " Buffalo Meal "	Syracuse	G F	7. 8.75	3. 4.09	7. 6.07	Corn and cob meal, the amount of cob used being the same as though ear corn was ground cob and all. As certified.
4010	General Flour & Feed Co., Buffalo, N. Y. " Meal "	Camden	G F	—— 9.66	—— 3.73	—— 1.37	Corn meal. As certified.
4034	Gilbert & Nichols Co., Fulton, N. Y. " Buckwheat Middlings "	Fulton	G F	—— 34.50	—— 8.78	—— 4.40	Buckwheat middlings, buckwheat hulls.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Continued*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Crude protein.	Crude fat.	Crude fiber.	Ingredients.
			Per ct.	*Per ct.*	*Per ct.*	
	MISCELLANEOUS FEEDS:					
4524	Grove Products Co., Jersey City, N. J. "Alpha Meal"	Port Chester	G* 11.22 F* 12.56	1.38 1.31	3.11 .36	Nabisco dough, low grade flour. As certified.
4348	The H-O Co., Buffalo, N. Y. "Force Screenings"	Buffalo	G 11. F 13.50	3. 3.90	9. 3.28	Wheat and salt. As certified.
4461	Hunter-Robinson-Wenz Milling Co., St. Louis, Mo. "Saxony Choice White Midds"	Newport	G 15. F 18.19	4. 5.32	6. 4.39	Pure winter wheat product. Wheat middlings.
4545	Henry Jennings, Boston, Mass. "H. J. Feed"	Livingston Manor	G 12.56 F 15.37	5.44 9.98	13.68 11.09	Ground screenings containing sand. Flax screenings and grain screenings containing a large amount of ground weed seeds, sand.
4069	Henry Jennings, Boston, Mass. "Improved Process H. J. Flax Feed"	Norwich	G 15. F 12.56	9. 5.44	6. 13.68	Ground screenings, containing sand.
4509	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Cream Flakes"	Walden	G 8.5 F 8.81	3.5 7.46	9. 8.13	Made from pure white corn. Consists largely of corn bran and corn meal, made from white corn.
4248	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Maizo Oil Meal"	Johnsons	G 15. F 12.38	5. 8.33	7. 5.38	Corn oil meal.

4398	Chas. A. Krause Milling Co., Milwaukee, Wis. "Badger Maizo Oil Meal"	Kingston	G F	16. 15.75	8. 6.52	5. 2.50	A pure corn product. Corn oil meal.
4377	The Meader-Atlas Co., New York, N. Y. "Ricefatfeed"	Rhinebeck	G F	10. 12.44	10. 12.01	13. 11.52	The cuticle of rice grain together with some broken rice and rice hull. As certified.
4429	North-West Mills Co., Winona, Minn. "Empire Fancy Heavy Mixed Feed"	Afton	G F	15. 15.81	3. 4.74	10. 6.48	Wheat bran, wheat middlings, ground screenings (weed seeds), grit.
3927	The Quaker Oats Co., Chicago, Ill. "Buckeye Mixed Feed"	Clarence	G F	13. 16.94	4. 5.29	8. 7.63	Wheat bran, wheat middlings and ground wheat. As certified.
4019	The Quaker Oats Co., Chicago, Ill. "Buckeye Mixed Feed"	Glenfield	G F	13. 17.56	4. 5.29	8. 7.68	Wheat bran, wheat middlings and ground wheat. As certified.
4089	The Quaker Oats Co., Chicago, Ill. "Buckeye Mixed Feed"	Afton	G F	13. 17.13	4. 5.22	8. 3.29	Wheat bran, wheat middlings and ground wheat. As certified.
4000	Ryan Bros., Jamesville, N. Y. "Barley Feed"	Syracuse	G F	12. 16.44	3.50 3.91	7.80 4.52	
4192	The Shredded Wheat Co., Niagara Falls, N. Y. "Shredded Wheat Waste for Poultry"	Niagara Falls	G F	10. 12.19	1.50 2.25	2. 2.11	Refuse of shredded wheat biscuit and floor sweepings. As certified.
3232	F. W. Stock & Sons, Hillsdale, Mich. "Monarch Mixed Bran and Middlings from Pure Wheat"	Sandy Creek	G F	—— 17.56	—— 5.85	—— 7.16	Wheat bran, wheat middlings and screenings.

* These letters indicate, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF FEEDING STUFFS — (*Concluded*).

Number.	Name and address of manufacturer or jobber and brand or trade name.	Where taken.		Crude protein.	Crude fat.	Crude fiber.	Ingredients.
				Per ct.	*Per ct.*	*Per ct.*	
	BEET SUGAR RESIDUES:						
3233	F. W. Stock & Sons, Hillsdale, Mich. "Monarch Mixed Bran and Middlings from Pure Wheat"	Lacona	G* F*	— 17.44	— 5.71	— 6.68	Wheat bran, wheat middlings and screenings.
4284	F. W. Stock & Sons, Hillsdale, Mich. "Monarch Mixed Bran and Middlings"	Syracuse	G F	— 17.56	— 5.61	— 7.01	From pure wheat. Wheat bran and screenings.
3840	Thompson Milling Co., Lockport, N. Y. "Angelus Bran"	Gasport	G F	— 15.81	— 5.18	— 9.43	Wheat bran and screenings.
4297	Thompson Milling Co., Lockport, N. Y. "Angelus Middlings"	Geneva	G F	— 18.75	— 5.60	— 7.50	Wheat middlings and finely ground screenings (weed seeds)
4611	Washburn Mills, Minneapolis, Minn. "Washburn-Crosby Co's Pure Hard Wheat Coarse Bran"	Potsdam	G F	14.50 16.63	4. 5.34	11. 8.99	Wheat bran and ground screenings (weed seeds).

* These letters indicate, respectively, Guaranteed and Found.

COMMENTS ON RESULTS OF INSPECTION, 1911–'12.

E. L. BAKER.

During the past five years the agents of the Commissioner of Agriculture have collected and the chemists of this Station analyzed, a steadily increasing number of brands of feeding stuffs. In 1907, as shown by Table I, 279 brands were inspected and 297 samples analyzed; while in 1912, 447 brands were inspected and 772 samples analyzed, these being increases, respectively, of 60 and 160 per ct. These increases, however, do not nearly represent the added amount of work along this line done at the Station; since the law in 1907 did not require guaranties of ingredients, while during the past three seasons these additional guaranties and examinations have been required for all goods made up of mixed materials. In 1912, more than 300 of the samples analyzed required this special examination, making an increase of from one-third to one-half the time required for these brands.

So far as serious deficiences from guaranty are concerned, the showing during this five-year period has been very satisfactory; as comparatively few of the samples have fallen much below their guaranties. These data are shown in Table II.

TABLE I.— WORK DONE IN FEEDING STUFFS INSPECTION LABORATORY, 1905–1912.

	Years							
	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Number of brands inspected	319	310	328	279	368	380	404	447
Number of samples analyzed	326	316	388	297	403	412	608	772
Number of brands below guarantee	103	104	62	28	22	39	43	60
Percentage of brands below guarantee	32	33	19	10	6	10	10	13

TABLE II.— NUMBER AND KINDS OF FEEDING STUFFS ANALYZED, 1911–'12.

CLASSIFICATION.	Number of brands sampled.	Number of samples analyzed.	Number of brands appreciably below guarantee.
Cottonseed meals	21	38	7
Linseed meals	11	23	2
Malt sprouts	28	45	2
Dried distillers' grains	30	61	4
Dried brewers' grains	14	24	2
Gluten feeds	11	26	1
Gluten meals	1	2	....
Hominy feeds	20	28	3
Compounded feeds	136	236	16

TABLE II.—NUMBER AND KINDS OF FEEDING STUFFS ANALYZED, 1911-'12—*cont'd.*

CLASSIFICATION.	Number of brands sampled.	Number of samples analyzed.	Number of brands appreciably below guarantee.
Molasses feeds (compounded)	46	91	7
Cottonseed feeds (compounded)	5	11	....
Poultry feeds (compounded)	36	65	6
Animal feeds	40	59	7
Alfalfa meals	18	27	....
Unclassified	30	36	3
Totals	447	772	60

The compounded feeds have greatly increased in number and many of them are composed in part, some largely, of inferior materials. This is particularly true of molasses feeds, in which are frequently found such adulterants as rice hulls, oat hulls, buckwheat hulls, corn cobs, peanut hulls, screenings, chaff, weed seeds and sand.

SCREENINGS.

Exceptions will doubtless be taken to the classification of weed seeds and screenings as inferior materials. Already, much has been claimed for the value of these substances for feeding purposes; but it must be remembered that screenings are grain refuses, which, coming as they do from different sources, are composed of a variety of materials, good and bad, and vary widely in their composition and digestibility.

Samples composed largely of broken and small sized grains of the cereal from which they are screened, such as the better grades of wheat screenings, doubtless rank fairly well in digestibility. On the other hand screenings containing chaff, straw, dust, dirt, and other low grade refuse, include much highly indigestible material.

Samples of weed seeds sometimes contain harmful as well as undesirable varieties and it has been shown repeatedly that unground seeds will pass through the digestive system of the animal without losing their viability. Many of them will germinate upon reaching the soil.

Until these refuses are graded or standardized and rated according to their true value, their presence in cattle feeds cannot be looked upon with favor and the feeder cannot afford to purchase at grain prices such nondescript materials.

SAND IN FEEDING STUFFS.

In the last feeding stuffs bulletin* published by this Station, it was shown that many feeds, noticeably samples composed in part of screenings, contained appreciable amounts of sand.

* N. Y. Agr. Exp. Sta. Bull. No. 340.

During the season of 1911–'12, seventy-four compounded feeds have been found to contain screenings and in twenty-nine of these sand is present in rather large quantities. Twenty-five contain only small amounts and twenty, none or only traces. No sand was found in any materials free from screenings.

Whether or not sand is deliberately added to feeds, it is evident that the use of screenings accounts largely for its presence. However, the fact that twenty samples containing screenings were free from sand goes to show that it is not a necessary part of this refuse, and that if proper measures are taken it can and should be eliminated.

The following tables give the proportion of ash, sand and silica in samples containing screenings. For comparison figures are also given for a few samples to which no screenings have been added.

Table III.— Ash, Sand and Silica in Feeding Stuffs.

Samples containing screenings and sand.			Samples containing screenings and grit or small amount of sand.		
Sample No.	Ash.	Silica and sand.	Sample No.	Ash.	Silica and grit.
	Per ct.	*Per ct.*		*Per ct.*	*Per ct.*
3956	8.19	3.05	3229	7.44	2.27
3965	8.09	2.91	3243	7.91	2.39
3984	9.40	4.01	3912	4.52	1.93
4008	9.39	3.14	3932	3.66	1.78
4011	8.88	2.77	3940	7.29	2.27
4069	10.37	6.58	3994	6.86	1.24
4082	8.34	3.00	4023	7.70	2.03
4087	9.48	3.35	4040	5.17	1.49
4111	8.96	2.75	4143	6.89	1.10
4112	8.17	2.94	4156	6.82	1.32
4113	9.22	3.45	4200	6.39	1.39
4115	7.41	2.84	4314	5.59	3.26
4136	8.27	2.33	4327	7.77	2.53
4148	8.67	3.32	4385	6.33	1.37
4173	7.06	2.46	4417	9.23	1.80
4215	8.66	3.06	4432	3.49	1.38
4228	7.62	3.09	4437	8.71	2.98
4263	9.58	3.24	4463	8.13	2.31
4280	7.62	2.69	4472	8.61	3.20
4330	9.91	3.03	4504	6.34	1.87
4333	9.39	3.86	4544	7.82	2.23
4378	11.41	5.22	4558	5.19	1.98
4396	7.23	2.82	4559	5.61	1.97
4406	6.12	2.96	4573	6.24	1.38
4411	9.84	3.11	3913	7.20	2.27
4436	6.81	2.33			
4451	8.75	3.56			
4455	10.09	3.40			
4545	7.16	3.96			
Average	8.62	3.28	Average	6.68	1.99

TABLE III.— ASH, SAND AND SILICA IN FEEDING STUFFS (*continued*).

Samples containing screenings and no sand or only traces.			Samples free from screenings and sand.		
Sample No.	Ash.	Silica.	Sample No.	Ash.	Silica.
	Per ct.	*Per ct.*		*Per ct.*	*Per ct.*
3232	4.96	.30	Brewers' grains	3.11	1.23
3233	5.36	.23	Malt sprouts	5.82	1.05
3243	7.69	2.38	Hominy feed	2.50	.14
3820	3.15	1.29	Gluten feed	4.06	.51
3840	6.39	.37	Cottonseed meal	7.08	.15
4037	5.69	1.55	Alfalfa meal	7.85	.29
4050	7.70	.85	Linseed meal	5.00	.27
4151	5.32	1.63	Corn meal	2.18	.10
4198	3.24	1.15	Wheat middlings	3.94	.12
4283	5.60	1.44	Distillers' grains	4.13	.33
4374	6.43	.80	3950 (compounded)	2.81	.83
4376	6.27	.77	3933 (compounded)	5.41	.72
4392	3.02	1.35	3954 (compounded)	4.81	.56
4418	7.37	1.43	4031 (compounded)	5.66	.68
4449	6.54	1.26	4066 (compounded)	3.00	.74
4462	7.08	.58	4551 (compounded)	5.58	.30
4484	6.70	2.28			
4510	5.37	1.66			
4528	4.97	1.88			
4580	7.14	2.50			
Average	5.79	1.28	Average	4.56	.50

The preceding figures are to a certain extent a measure of the proportion of sand in feeds. They show clearly that samples containing it average much higher in ash and silica than those in which it is absent.

The finding of sand has been substantiated in every case by careful microscopical examination of the ash.

COMPOSITION OF FEEDING STUFFS.

A cattle food in its rôle as a "nutrient" is composed of groups of chemical compounds which have certain functions to perform in the production of energy and the building up of the animal body. The determination of the amounts of these different groups constitutes the chemical analysis of a feed. The groups are described as follows:

Moisture.— The water content of a feeding stuff. All feeds contain a varying amount of water, which is not considered as having any nutritive value.

Ash is the mineral matter of a food which remains after ignition. It is composed chiefly of phosphates, chlorides, sulphates and carbonates of calcium, magnesium, sodium and potassium; and is valu-

able to the animal in furnishing material for bone structure and in the formation of the soft tissues of the body.

Protein is the nitrogenous part of a feed; and is of great importance as it forms muscle, ligaments, hair, hide and bones in the animal body. It is also a source of energy under all conditions of nutrition, and in case a proper proportion of carbohydrates and fats is not maintained in the ration, its use as a source of energy may be greatly increased.

Fat (or *Ether extract*) is that portion of a feed which is soluble in ether. It is composed chiefly of oils and fats, and may contain in addition a large amount of resinous substances and coloring matter. The oils and fats contained in this extract may be utilized by the animal for the production of fat and energy.

Fiber is the woody matter which forms the framework of plants. It is considered the most indigestible part of a feed.

Nitrogen-free extract consists of non-nitrogenous bodies such as starches, sugars, gums, vegetable acids, etc., and is useful in supplying fat and energy. It is not ordinarily determined by chemical analysis but is obtained by subtracting the sum of the percentages of moisture, ash, protein, fat and fiber from 100.

The nitrogen-free extract and crude fiber taken together are termed "carbohydrates."

DIGESTIBILITY AND NUTRITIVE RATIO.

The groups just described constitute the nutrients of a feeding stuff. Before any of these substances can be used by the animal, it must be dissolved by the action of the digestive juices of the mouth, stomach and intestines. This process of solution is called digestion. It should be understood that the constituents of no cattle food are entirely digested, and that owing to the composition of the material, appreciable quantities are wasted.

The percentage of a nutrient which is removed from a food by digestion is called the "*Digestion coefficient*," or the "*Percentage of digestibility.*"

Digestion coefficients for many of the grains, grain by-products and fodders have been determined by repeated experiments.

In order to determine the quantities of "*Digestible nutrients*" in a food it is necessary to multiply the percentage of protein, fat, fiber, etc., by the digestion coefficient of each nutrient. For example, if a gluten feed contains 24 per ct. of protein, which has a digestion coefficient of 85.6, the material would contain $(85.6 \times 24) \div 100$ or 20.5 lbs. of digestible protein in 100 lbs. of feed. A similar process is necessary for each of the other nutrients.

The *Nutritive ratio* of a feeding stuff is the relation in quantity between the digestible nutrients which it contains. By this term is meant the relation of the digestible protein to all the other diges-

tible organic matter expressed in terms of carbohydrates. Since fat is 2.4* times as valuable as carbohydrates for the production of energy, the first step in obtaining the nutritive ratio of a feed is to multiply the percentage of digestible fat by 2.4 which gives its carbohydrate equivalent. To the product is added the percentage of digestible carbohydrates, the sum being the digestible matter other than protein, expressed on a carbohydrate basis. The nutritive ratio is then found by the proportion, Protein: Carbohydrates :: 1 : ×. Example: To determine the nutritive ratio of brewers' grains, containing 15.8 per ct. digestible protein, 5.1 per ct. digestible fat and 35.7 per ct. digestible carbohydrates:

$5.1 \times 2.4 = 12.2$ carbohydrate equivalent of fat.
$12.2 + 35.7 = 47.9$ carbohydrate equivalent of fat, + carbohydrates.
$15.8 : 47.9 :: 1 : \times$
$47.9 \div 15.8 = 3.0$
$1 : 3 =$ nutritive ratio.

The average composition, digestible nutrients and digestion coefficients of feeding stuffs are given in the following table. By the use of this table and the above methods, the digestible nutrients and nutritive ratio of any feed of known composition may be computed.

*Some authorities use 2.25.

FEEDING STUFF.	Composition.						Digestible nutrients in 100 pounds.			Digestion coefficients.			
	Water.	Ash.	Crude protein.	Crude fat.	Crude fiber.	Nitrogen free extract.	Crude protein.	Crude fat.	Carbohydrates.	Crude protein.	Crude fat.	Crude fiber.	Nitrogen free extract.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Lbs.	Lbs.	Lbs.	Per ct.	Per ct.	Per ct.	Per ct.
Barley	10.9	2.4	12.4	1.8	2.7	69.8	8.7	1.6	65.6	70.0	89.0	50.0	92.0
Beet pulp, dried*	8.0	5.4	9.5	.4	15.4	61.3	6.1	.4	68.7	64.0	....	84.0	91.0
Brewers' grains, dried	8.2	3.6	19.9	5.6	11.0	51.7	15.8	5.1	35.7	79.3	91.1	52.6	57.8
Buckwheat	12.6	2.0	10.0	2.2	8.7	64.5	7.7	1.8	49.2	......	....	....	....
Buckwheat middlings	13.2	4.8	28.9	7.1	4.1	41.9	22.0	5.4	33.4	85.1	89.4	16.9	83.3
Buckwheat hulls	13.2	2.2	4.6	1.1	43.5	35.3	2.1	.6	27.9	......	....	....	....
Corn	10.6	1.5	10.3	5.0	2.2	70.4	7.9	4.3	66.7	76.0	86.0	58.0	93.0
Corn meal	15.0	1.4	9.2	3.8	1.9	68.7	6.2	3.5	65.0	67.9	92.1	....	94.6
Corn bran	9.1	1.3	9.0	5.8	12.7	62.2	4.9	4.5	55.4	54.0	77.0	59.0	77.0
Corn cob	10.7	1.4	2.4	.5	30.1	54.9	.4	.3	52.5	17.0	50.0	65.0	60.0
Corn and cob meal	15.1	1.5	8.5	3.5	6.6	64.8	4.4	2.9	60.0	52.0	84.0	45.0	88.0
Cottonseed meal	8.2	7.2	42.3	10.8	5.4	26.1	37.4	10.0	18.8	88.4	93.0	55.5	60.6
Cottonseed hulls	11.1	2.8	4.2	2.2	46.3	33.4	.3	1.7	33.1	6.0	79.0	47.0	34.0
Dried blood	8.5	4.7	81.4	.5	....	......	52.3	....	......	62.0	100.0	....	100.0
Dried distillers' grains (largely from corn)	6.5	2.3	32.4	12.0	13.0	33.8	23.6	11.4	39.7	73.0	95.0	95.0	81.0
Flaxseed	9.2	4.3	22.6	33.7	7.1	23.2	20.6	29.0	17.1	91.0	86.0	60.0	55.0
Gluten feed	7.8	1.1	24.0	3.3	5.3	51.2	20.5	2.8	49.8	85.6	84.4	78.0	89.2
Gluten meal	12.3	1.3	36.5	2.7	1.4	45.8	32.1	2.5	40.3	88.0	93.0	....	88.0
Hominy feed	11.1	2.5	9.8	8.3	3.8	64.5	6.4	7.6	60.0	65.0	92.0	67.0	89.0
Linseed meal, old process	8.3	5.3	35.7	7.2	7.5	36.0	31.7	6.4	32.2	88.8	88.6	57.0	77.6
Linseed meal, new process	10.0	5.2	36.1	3.6	8.4	36.7	30.8	3.5	38.4	85.2	96.6	80.4	86.1

* Ind. Agr. Exp. Sta. Bull. No. 141.

TABLE IV.—AVERAGE COMPOSITION, DIGESTIBLE NUTRIENTS, AND DIGESTION COEFFICIENTS OF FEEDING STUFFS (*continued*).

FEEDING STUFF.	Composition.						Digestible nutrients in 100 pounds.			Digestion coefficients.			
	Water.	Ash.	Crude protein.	Crude fat.	Crude fiber.	Nitrogen free extract.	Crude protein.	Crude fat.	Carbohydrates.	Crude protein.	Crude fat.	Crude fiber.	Nitrogen free extract.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Malt sprouts..........	5.0	6.4	27.6	3.0	10.9	47.1	22.1	3.0	36.2	80.0	100.0	34.0	69.0
Oats..................	11.0	3.0	11.8	5.0	9.5	59.7	9.2	4.2	47.3	78.0	83.0	20.0	76.0
Oat middlings.........	9.0	2.3	15.8	6.2	2.4	64.3	12.8	5.8	63.0	81.0	94.0	49.0	96.0
Oat hulls.............	7.3	6.7	3.3	1.0	29.7	52.1	1.3	.6	40.1	......	....	....	....
Rice..................	12.4	.4	7.4	.4	.2	79.2	4.8	.3	72.2	......	....	....	....
Rice meal.............	10.2	8.1	12.0	13.1	5.4	51.2	7.0	11.1	45.4	63.0	85.0	26.0	86.0
Rice polish...........	10.0	6.7	11.7	7.3	6.3	58.0	7.7	5.4	55.3	66.0	74.0	22.0	93.0
Rice hulls............	8.2	13.2	3.6	.7	35.7	38.6	1.6	.6	44.5	......	....	....	....
Rye...................	11.6	1.9	10.6	1.7	1.7	72.5	8.4	1.3	52.1	79.4	74.5	79.2	70.1
Rye bran..............	11.6	3.6	14.7	2.8	3.5	63.8	11.5	2.0	50.3	......	....	....	....
Rye middlings.........	11.8	1.7	14.3	2.9	2.4	66.9	......	....	......	......	....	....	....
Wheat.................	10.5	1.8	11.9	2.1	1.8	71.9	10.2	1.7	69.2	......	....	....	....
Wheat bran............	11.9	5.8	15.4	4.0	9.0	53.9	12.0	2.7	40.0	77.8	68.0	28.6	69.4
Wheat middlings.......	10.0	3.8	17.4	5.6	5.2	58.0	14.3	4.8	51.2	82.0	85.0	36.0	85.0

Table IV.— Average Composition, Digestible Nutrients, and Digestion Coefficients of Feeding Stuffs (*continued*).

Roughage.	Composition.						Digestible nutrients in 100 pounds.			Digestion coefficients.			
	Water.	Ash.	Crude protein.	Crude fat.	Crude fiber.	Nitrogen free extract.	Crude protein.	Crude fat.	Carbohydrates.	Crude protein.	Crude fat.	Crude fiber.	Nitrogen free extract.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Corn fodder, field cured	42.2	2.7	4.5	1.6	14.3	34.7	2.5	1.2	34.6	55.0	74.0	65.0	73.0
Corn stover, field cured	40.5	3.4	3.8	1.1	19.7	31.5	1.7	.7	32.4	45.0	62.0	67.0	61.0
Corn silage	79.1	1.4	1.7	.8	6.0	11.0	.9	.6	11.5	49.3	80.0	66.7	68.6
Barley straw	14.2	5.7	3.5	1.5	36.0	39.0	.7	.6	41.2	20.0	42.0	56.0	54.0
Wheat straw	9.6	4.2	3.4	1.3	38.1	43.4	.4	.4	36.3	11.0	31.0	52.0	38.0
Oat straw	9.2	5.1	4.0	2.3	37.0	42.4	1.2	.8	38.6	30.0	33.0	54.0	44.0
Rye straw	7.1	3.2	3.0	1.2	38.9	46.6	.6	.4	40.6	21.0	32.0	60.0	37.0
Buckwheat straw	9.9	5.5	5.2	1.3	43.0	35.1	....	....	......	....	....	....	......
Alfalfa hay	8.4	7.4	14.3	2.2	25.0	42.7	10.6	.9	38.9	74.0	39.0	43.0	66.0
Timothy hay	13.2	4.4	5.9	2.5	29.0	45.0	2.8	1.4	43.4	48.0	57.0	52.0	63.0
Red clover hay	15.3	6.2	12.3	3.3	24.8	38.1	6.8	1.7	35.8	55.0	53.0	46.0	64.0
White clover hay	9.7	8.3	15.7	2.9	24.1	39.3	11.5	1.5	42.2	73.0	51.0	61.0	70.0
Alsike clover hay	9.7	8.3	12.8	2.9	25.6	40.7	8.4	1.5	42.5	66.0	50.0	53.0	71.0

Note.— The data for this table were taken largely from "Jordan's Feeding of Farm Animals," "Voorhees' Forage Crops," and "Henry's Feeds and Feeding."

TABLE V.— APPROXIMATE WEIGHT OF ONE QUART OF FEEDING STUFFS.

	Lbs.		Lbs.
Alfalfa meal	.43	Malt sprouts	.51
Barley	1.35	Hominy feed	.87
Wheat	1.65	Gluten feed	1.07
Rye	1.35	Gluten meal	1.47
Corn	1.51	Cottonseed meal	1.03
Oats	.85	Cottonseed feed (meal and hulls)	1.00
Wheat middlings	.73	Linseed meal	1.17
Wheat bran	.45	Dried beet pulp	.49
Corn meal	1.03	Pea meal	1.11
Corn bran	.39	Blood meal	1.03
Corn distillers' grains (dried)	.53	Animal meal	1.58
Rye distillers' grains (dried)	.41	Beef scraps	1.36
Dried brewers' grains	.50	Digester tankage	1.11

The weights in the above table may be found useful in compounding daily rations. They were determined by carefully weighing one quart of feed.

TABLE VI.— COMPOSITION OF CERTAIN INFERIOR MATERIALS LARGELY USED TO ADULTERATE FEEDING STUFFS.

MATERIAL.	Water.	Ash.	Protein.	Fat.	Fiber.	Nitrogen free extract.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Buckwheat hulls	9.6	2.2	4.9	1.1	42.9	39.3
Corn cobs	8.0	1.3	2.7	.5	31.3	56.2
Cottonseed hulls	10.4	2.6	4.0	2.0	44.4	36.6
Oat feed (mostly hulls)	7.0	5.5	5.1	1.6	26.4	54.4
Oat hulls	7.3	6.7	3.3	1.0	29.7	52.0
Peanut feed (largely husks)	10.0	2.6	8.9	5.5	56.4	16.6
Peanut husks	13.0	1.2	5.0	1.7	66.0	13.1
Peanut shells	8.5	2.5	7.1	2.5	60.7	18.7
Rice hulls	10.5	17.4	4.6	.7	38.9	27.9

These materials are characterized by a low protein and high fiber content, a condition which is always attended by low digestibility. They are often used in compounded feeds which sell at grain prices.

PURE AND ADULTERATED GROUND FARM GRAIN MIXTURES.

Many of the feeding stuffs found upon the markets of this state are or appear to be composed of ground cereal grains such as corn, oats, barley and rye, particularly the two former.

The practice of grinding or mixing oat hulls with the aforesaid cereals is of frequent occurrence and the use of oat clippings and corn offals is not unknown.

There is no criticism intended for the manufacturer who truthfully labels and sells such feeds at a fair price. In that case the buyer can

use his own judgment as to whether he should purchase feeds composed in part of inferior materials.

Although the majority of millers are properly branding their goods, deception is still much more general than one would imagine.

As an aid in interpreting the chemical analysis of cereals mixed in various proportions, the following average analyses are given:

Table VII.— Chemical Composition of Cereal Mixtures.

	Protein.	Fat.	Fiber.
	Per ct.	*Per ct.*	*Per ct.*
Oats	11.8	5.0	9.5
Corn meal	9.2	3.8	1.9
Corn and oats (equal parts by weight)	10.5	4.4	5.7
Corn, 75 per ct., oats, 25 per ct	9.8	4.1	3.8
Corn, 25 per ct.; oats, 75 per ct	11.1	4.7	7.6
Corn, oats and barley (equal parts by weight)	11.5	4.0	4.7
Corn, oats and rye (equal parts by weight)	10.9	4.0	4.4

RETAIL PRICES.

The cost of feeding stuffs has never been higher than at the present time, and the buyer should use great care in his selection. In the following table are given the average partial composition and range in retail prices per ton of some feeds commonly found upon the markets of this State. They are classified according to the percentage of protein which they contain.

Table VIII.— Composition and Retail Prices per Ton.

FEEDING STUFF.	Protein.	Fat.	Fiber.	Price per ton.
Class I (30–45 Per Ct. Protein):	*Per ct.*	*Per ct.*	*Per ct.*	
Gluten meal	43.07	2.33	1.08	$36
Cottonseed meal	40.62	7.67	7.79	33–40
Linseed meal (old process)	35.7	7.2	7.5	38–45
Dried distillers' grains (largely from corn)	32.4	12.0	13.0	30–35
Class II (20–30 Per Ct. Protein):				
Buckwheat middlings	28.9	7.1	4.1	28
Dried brewers' grains	27.62	7.16	12.66	25–34
Malt sprouts	27.6	3.0	10.9	23–27
Unicorn dairy ration	26.47	6.63	7.59	31
Blue ribbon dairy feed	26.18	4.57	8.81	30–32
Union grains	24.96	7.65	7.70	32–33
Honest cow feed	24.82	8.24	7.88	30
Gluten feed	24.0	3.3	5.3	29–31
Cottonseed feed	20.48	4.38	21.04	27–31

TABLE VIII.— COMPOSITION AND RETAIL PRICES PER TON (*continued*).

FEEDING STUFF.	Protein.	Fat.	Fiber.	Price per ton.
CLASS III (14–20 PER CT. PROTEIN):	*Per ct.*	*Per ct.*	*Per ct.*	
Daisy dairy feed	19.25	3.58	13.00	$26
Rye distillers' grains	18.60	6.54	11.43	25–27
Husted laying mash	17.88	5.27	4.63	35
Pea meal	17.75	1.31	23.69	20
Wheat middlings	17.4	5.6	5.2	31–35
Wheat mixed feed	17.13	5.07	7.74	29–33
Sugarine dairy feed	17.04	4.43	9.60	23.50
Barley feed	16.44	3.91	4.52	28
Badger dairy feed	16.42	2.01	9.34	25
International special molasses feed	15.83	5.17	11.29	25–27
Wheat bran	15.4	4.0	9.0	31
U. S. sugar feed	15.4	3.39	9.03	26
Holstein sugar feed	15.31	4.22	7.42	28
Alfalfa meal	14.5	1.71	29.1	31–40
Corn oil meal	14.07	7.43	3.94	29
CLASS IV (8–14 PER CT. PROTEIN):				
Ground screenings (mostly ground weed seeds	12.56	5.44	13.68	25
No. 2 chop feed (corn, oats and wheat bran ⅓ each)	11.63	4.23	4.28	35
H. O. Co. algrane horse feed	11.40	4.07	8.99	32
H. O. Co. algrane scratch feed	11.35	3.24	11.73	44
Schumacher stock feed	10.94	3.84	8.70	30
Oneida mixed feed	10.08	2.97	13.02	28
Sterling mixed feed	9.91	3.27	12.50	23
Hominy feed	9.8	8.3	3.8	30–33
Monarch chop	9.72	4.62	5.73	29
Star feed	9.61	6.67	9.21	30–32
Dried beet pulp	9.5	.4	15.4	24–26
Hammond stock feed	9.44	2.38	7.90	24
Grandins stock feed	9.25	3.47	5.53	30
Corn meal	9.2	3.8	1.9	27–32
Jem feed	9.16	3.63	7.24	32
Husted yellow provender	8.71	3.43	3.67	32
Corn and cob meal	8.5	3.5	6.6	30
Molasses corn flakes	8.2	4.67	8.86	24.50
Special proprietary mixtures:				
International grofast calf meal	28.15	5.6	7.45	56
Sugaroto calf meal	25.19	5.29	3.57	*3
Blatchford's calf meal	24.12	5.09	5.25	*3.50
Schumacher calf meal	19.88	7.37	1.86	†3c.
Animal byproducts:				
Dried blood	84.4	.5	......	67–90
Eaton's high grade beef scrap	57.25	12.92	......	*3
Pure beef cracklings	51.01	16.15	......	*3
Bone and meat meal	41.0	10.67	......	*2.50
Bowker's animal meal	40.38	51.62	......	*2.50

* Per cwt. † Per lb.

A careful inspection of the figures in tables IV and VIII shows that in many cases there is little relation between the prices charged for feeding stuffs and their composition as determined by chemical analysis. The cost of some feeds is way out of proportion to their nutritive value.

The brands mentioned in this table were chosen merely for purposes of comparison of the several classes of materials in relation to their composition and prices.

In the selection of proper feeding materials the actual analysis is not so important as the proportion of digestible matter. The ingredients of which they are composed should also be taken into careful consideration.

In Table IV may be found the digestible nutrients for many of the concentrates and fodders. Very little data is to be had upon the digestibility of compounded feeds and grain refuses.

FEEDING STUFFS' DEFINITIONS.

The following feeding stuffs' definitions are, with the exception of a few changes, essentially those adopted by the Association of Feed Control Officials at Columbus, Ohio, in November, 1911:

Meal is the clean, sound, ground product of the entire grain, cereal or seed which it purports to represent; provided that the following meals, qualified by their descriptive names, are to be known as, viz.:

Corn germ meal is chiefly the germ of the corn kernel from which a part of the oil has been extracted.

Linseed meal is the ground residue after extraction of a large part of the oil from ground flax seed.

Hominy meal, hominy feed or *hominy chop* is a mixture of the bran coating, the germ and a part of the starchy portion of the corn kernel.

Grits are the hard flinty portions of Indian corn without hulls and germ.

Corn bran is the outer coating of the corn kernel.

Wheat bran is the coarse outer coatings of the wheat berry.

Wheat shorts or *standard wheat middlings* are the fine particles of the outer and inner bran separated from bran and white middlings.

Wheat mixed feed is a mixture of the products other than the flour from the milling of the wheat berry.

Red dog is a low grade wheat flour containing the finer particles of bran.

Oat groats are the kernels of the oat berry with the hulls removed.

Oat shorts or *oat middlings* are the coverings of the oat grains lying immediately inside the hulls. These make a fuzzy material carrying with it considerable portions of the fine floury part of the groat obtained in the milling of rolled oats.

Oat clippings are the hairs, oat dust, ends of oats and light oats separated from the oat kernel by the clipping process.

Oat hulls are the outer chaffy coverings of the oat grain.

Rice hulls are the outer chaffy coverings of the rice grain.

Rice bran is the cuticle beneath the hull.

Rice polish is the finely powdered material obtained by polishing the kernel.

Flax plant by-product is that portion of the flax plant remaining after the separation of the seed, the bast fiber and portions of the shives; and consists of flax shives, flax pods, broken and immature flax seeds and the cortical tissue of the stem.

Buckwheat shorts or *buckwheat middlings* are those portions of the buckwheat grains immediately inside of the hulls after separation from the flour.

Blood meal is ground dried blood.

Meat scrap and *meat meal* are the ground residues from animal tissue, practically exclusive of hoof and bone. If they contain any considerable amount of bone, they must be designated meat and bone scrap, or meat and bone meal. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

Cracklings are the residue after partially extracting the fats and oils from animal tissue. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

Digester tankage is the residue from animal tissue practically exclusive of hoof and horn, specially prepared for feeding purposes by tanking under live steam, drying under high heat and suitable grinding. If it contains any considerable amount of bone, it must be designated digester meat and bone tankage.

Distillers' dried grains are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors.

Brewers' dried grains are the properly dried residue from cereals, mostly barley, obtained in the manufacture of beer.

Malt sprouts are the sprouts of the barley grain. If the sprouts are derived from any other malted cereal the source must be designated.

Alfalfa meal is the entire alfalfa hay ground and does not contain an admixture of ground alfalfa straw or other foreign materials.

Chop is a ground or chop feed composed of one or more different cereals. If it bears a name descriptive of the kind of cereals, it must be made exclusively of the entire grains of those cereals.

Screenings are the smaller imperfect grains, weed seeds and other foreign materials separated in cleaning the grain.

MISUSE OF TERMS.

Corn meal: According to definition this should be the sound, ground product of the entire grain. In the milling of corn for the production of food products such as table meal, breakfast foods, etc., certain portions of the kernel are removed. That which remains is a coarser product, having somewhat the appearance of the ground grain. This substance is not corn meal in the true meaning of the term, yet it frequently appears upon the market under that name.

The term " corn meal " should not be applied to any material other than ground, clean, sound corn, from which no portion of the kernel has been removed.

Corn bran: This is defined as the outer coating of the corn kernel.

Certain residues from corn, obtained in the manufacture of table meal and other foods, composed largely of the outer covering of the corn kernel, but containing in addition a generous amount of the woody ends of the grains, the yellow grits and more or less germ and chaffy matter, are found upon the markets of this State under the name " corn bran." They are improperly branded.

Corn bran is a uniform material running from 11 to 12 per ct. protein, while the products referred to are variable in composition and seldom exceed 9 per ct. of protein. Pure corn bran should be the outer skin of the corn kernel, free from more than traces of any other substance.

Corn offal: In this bulletin the term " corn offal " has been used to describe the low grade materials occurring in shelled corn, such as corn cob, immature and damaged kernels, coarse and fine particles of corn husks, glumes, and dust. This use of the term, however, is unsatisfactory, as corn offals are, strictly speaking, residues from the kernel after certain portions have been removed. Similarly, wheat by-products in the manufacture of flour are known as " wheat offals."

Oat middlings are really the floury portion of the oat groat, although they are usually obtained in combination with the bran or inner covering of the oat grain. In such cases it is commonly the practice of stating both oat middlings and oat shorts as ingredients. Since the definition of oat shorts or oat middlings includes both these materials, it is preferable that only one ingredient should be guaranteed.

The use of "oat clippings" under the name "oat middlings" or "oat shorts" is clearly intended to mislead and will be held as misbranding.

Oat feed: The term "oat feed" should not be used. If oat by-products are used in compounding a feed, each ingredient should be named separately.

Oat clippings: "Oat clippings" have been defined as being "the hairs, oat dust, ends of oats and light oats separated from the oat kernel by the clipping process."

As they appear on the market in feed mixtures they seldom correspond with this definition.

In the process of clipping, the oats are run into rapidly revolving drums or cylinders, where they are rubbed together until the fuzzy ends, small portions of the oat groats and more or less hulls and light oats are removed. Coincident with this process is the separation of the refuse matter from the grain, such as dust, dirt, chaff, straw, stems and weed seeds, or in other words, the clipping and screening or cleaning of the grain is often done in one process. Apparently the clippings and more or less refuse are run together and sold or mixed in feeds under the name "oat clippings."

It is plain that this term is not properly descriptive. For this reason it has been necessary in this bulletin to go further and state exactly what is found. If clippings, screenings and weed seeds are used they should be so named.

The analysis and composition of several samples of so-called clippings appear in the table on the opposite page.

Buckwheat middlings: Mixtures of buckwheat middlings and buckwheat hulls are often sold as buckwheat middlings. Such samples are regarded as misbranded.

Cottonseed hull bran is a misnomer. It is only another name for finely ground cottonseed hulls containing more or less lint.

Rice bran is defined as the cuticle beneath the hull. This term is often erroneously applied to a mixture of rice bran and rice hulls.

Bran, shorts or *middlings:* It quite frequently happens that these terms are used alone. This may lead to confusion. They should therefore never be used without the qualifying name of the cereal from which they are derived.

Example: Wheat bran, oat shorts, wheat middlings.

Malted barley: This term should never be applied to brewers' grains.

Linseed meal is preferable to the term "oil meal."

Gluten: The term "gluten" is not sufficient but should appear as "gluten feed" or "gluten meal" as the facts may warrant.

TABLE IX.— ANALYSIS OF SAMPLES OF "OAT CLIPPINGS."

Sample No.	Water.	Ash.	Protein.	Fat.	Fiber.	Nitrogen-free extract.	Silica and grit.	Ingredients identified by microscopical examination.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
1.......	7.14	8.92	7.25	1.69	20.40	54.60	6.11	Oat glumes, oat hulls, light oats, oat bran, oat straw and stems, broken pieces of corn, corn bran and blowings from corn, weed seeds partly ground, dust and grit.
2.......	7.67	9.96	8.63	2.78	20.00	50.96	6.17	Large amount of oat hulls, large amount of oat bran, broken pieces of the oat berry (largely the end of the oat), some light oats, a very large amount of oat chaff consisting mostly of (glumes, shrunken and undeveloped kernels, oat hairs and oat dust) grit.
3.......	6.39	14.41	10.75	4.54	13.57	50.34	9.81	Oat hulls, large amount of oat bran, broken pieces of the oat berry (small amount), large amount of light oats, a very large amount of oat chaff consisting mostly of (glumes, pieces of straw and stems, shrunken and undeveloped kernels, oat hairs and oat dust) blowings from corn, a small amount of weed seeds, grit.
4.......	5.66	12.26	11.63	3.82	16.48	50.15	6.97	Large amount of oat hulls, large amount of oat bran, some light oats, large amount of oat chaff consisting mostly of (glumes, pieces of straw and stems, shrunken and undeveloped kernels, oat hairs and dust) blowings from corn, ground weed seeds, and grit.

Hominy: This term should not be used alone but should always appear as " hominy feed," " hominy meal " or " hominy chop."

Screenings: One of the most serious attempts to mislead and defraud arises from the practice of compounding feeds with grain screenings, containing a certain amount of broken and damaged grains, and upon the strength of the presence of these particles of the cereals from which the screenings are obtained, guarantees are maintained which would lead to the assumption that the commodities are composed of pure, sound grains, whereas only screenings have been used.

Example: A certain sample of feed was certified to be composed of cottonseed meal, oats, barley, wheat, grain screenings, malt sprouts, molasses and salt. A careful examination showed that the true composition of the feed was cottonseed meal, *screenings* from oats, barley and wheat, malt sprouts, molasses, and salt.

When a cereal is named as an ingredient, it is expected to be *clean, sound, sweet* and of good quality. The form, whether *whole, cracked* or *ground* should be given.

PROVISIONS OF THE AGRICULTURAL LAW RELATING TO THE SALE AND ANALYSIS OF CONCENTRATED COMMERCIAL FEEDING STUFFS.

ARTICLE VII*

Sale and Analysis of Concentrated Commercial Feeding Stuffs.

§ 160. **Term "concentrated commercial feeding stuffs" defined.** — The term "concentrated commercial feeding stuffs" as used in this article, shall include linseed meals, cotton seed meals, pea meals, bean meals, peanut meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried distillers' grains, dried brewers' grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, dried beet refuse, oat feeds, corn and oat chops, corn and cob meal, ground beef or fish scraps, meat meals, meat and bone meals mixed, dried blood, mixed feeds, clover meals, alfalfa feeds and meals, compounded feeds, condimental stock and poultry foods, proprietary or trade-marked stock and poultry foods, and all other materials of similar nature; but shall not include hays and straws, the whole seeds nor the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, corn, buckwheat and broom corn, neither shall it include wheat, rye and buckwheat brans or middlings, not mixed with other substances, but sold separately, as distinct articles of commerce, nor pure grains ground together, nor corn meal and wheat bran mixed together, when sold as such by the manufacturer at retail, nor wheat bran and middlings mixed together not mixed with any other substances and known in the trade as "mixed

Exceptions.

* Laws of 1909, Chapter 9, Article 7 (Chapter 1 of the Consolidated Laws).

feed," nor ground or cracked bone not mixed with any other substance, nor shall it include poultry foods consisting of whole or whole and cracked grains and grit mixed together when all the ingredients may be identified by the naked eye. (*As amended by chapter* 436 *of the Laws of* 1910.)

§ 161. **Statements to be attached to packages; contents; analysis.** — No manufacturer, firm, association, corporation or person shall sell, offer or expose for sale or for distribution in this state, any concentrated commercial feeding stuffs used for feeding live stock unless such concentrated commercial feeding stuffs shall be accompanied by or shall have affixed to each and every package in a conspicuous place on the outside thereof, a plainly printed statement which shall certify as follows:

1. The net weight of the contents of the package, except in the case of malt sprouts sold in packages containing uneven weights.
2. The name, brand or trade mark.
3. The name and principal address of the manufacturer or person responsible for the placing of the commodity upon the market.
4. Its composition expressed in the following terms:
   a. The minimum per centum of crude protein.
   b. The minimum per centum of crude fat.
   c. The maximum per centum of crude fiber, provided that the per centum of crude fiber may be omitted if it does not exceed five per centum.
   d. If a compounded feed, the name of each ingredient contained therein.
   e. If artificially colored, the name of the material used for such purpose.

If any such concentrated commercial feeding stuffs be sold, offered or exposed for sale in bulk, such printed statement shall accompany every car or lot.

Bulk goods.

Any such feeding stuffs purchased in bulk and later sacked or bagged for purposes of sale shall have tags attached giving the information as provided herein before being sold, offered or exposed for sale. Whenever any feeding stuff is sold at retail in bulk or in packages belonging to the purchaser, the seller upon request of the purchaser shall furnish the said purchaser the information contained in the certified statement provided herein.

Guaranteed analysis.

That portion of the statement required by this section relating to the quality of feeding stuffs shall be known and recognized as the guaranteed analysis. (*As amended by chapter* 317 *of the Laws of* 1909 *and by chapter* 314 *of the Laws of* 1911.)

§ 162. **Statements to be filed with commissioner of agriculture; to be accompanied by sample and affidavit when requested.**— Before any manufacturer, firm, association, corporation or person shall sell, offer or expose for sale in this state any concentrated commercial

feeding stuffs, he or they shall, for each and every brand of concentrated commercial feeding stuff, file annually prior to January first of the calendar year in which such commodity is to be sold, offered or exposed for sale with the commissioner of agriculture a certified copy of the statement, with the exception of the net weight of the contents of the package, specified in section one hundred and sixty-one, said certified copy to be accompanied, when the said commissioner shall so request, by a sealed glass jar or bottle containing at least one pound of the feeding stuff to be sold or offered for sale, and the company or person furnishing said sample shall thereupon make affidavit that said sample corresponds to the feeding stuff which it represents, in the per centum of crude protein, crude fat, crude fiber, name of each ingredient contained therein, if a compounded feed, and the name of any artificial coloring material used. (*As amended by chapter* 317 *of the Laws of* 1909 *and by chapter* 314 *of the Laws of* 1911.)

§ 163. **License fee.**— Every manufacturer, importer, agent or seller of any concentrated commercial feeding stuffs, shall pay annually prior to January first of the calendar year in which such commodity is to be sold, offered or exposed for sale to the treasurer of the state of New York a license fee of twenty-five dollars for each and every brand to be sold or offered or exposed for sale. Whenever a manufacturer, importer, agent or seller of any concentrated commercial feeding stuffs desires at any time to sell such material and has not complied with the requirements of the statute he shall before selling, offering or exposing the same for sale, comply with the requirements as herein provided. Said treasurer shall in each case at once certify to the commissioner of agriculture the payment of such license fee.

Certificate of commissioner.

Each manufacturer, importer or person who has complied with the provisions of this article shall be entitled to receive a certificate from the commissioner of agriculture setting forth said facts. Such certificate shall expire on the thirty-first day of December of the calendar year in which it was issued, but no such certificate shall be issued for the sale of a brand of concentrated commercial feeding stuff under a brand or trade name which is misleading or deceptive or which tends to mislead or deceive as to the constituents or materials of which it is composed.

Cancellation of.

Any such certificate so issued may be cancelled by the commissioner of agriculture when it is shown that any statement upon which it was issued is false or misleading. Whenever the manufacturer, importer or shipper of concentrated commercial feeding stuffs shall have filed the statement required by section one hundred and sixty-one of this article and paid the license fee as prescribed in this section, no agent or seller of such manufacturer, importer or shipper shall be required to file such statement or pay such fee. (*As amended by chapter* 317 *of the Laws of* 1909.)

§ 164. **Commissioner of agriculture to take samples for analysis; analysis to be made by director of experiment station.**— The commissioner of agriculture shall at least once in each year transmit to the New York agricultural experiment station for analysis at least one sample to be taken in the manner hereinafter prescribed, of the different concentrated commercial feeding stuffs sold or offered for sale under the provisions of this article. The said commissioner of agriculture or his duly authorized representative in taking samples shall take them in duplicate in the presence of at least one witness, and in the presence of such witness shall seal such samples and shall at the time of taking tender, and if accepted, deliver to the person apparently in charge one of such samples; the other sample the commissioner of agriculture shall cause to be analyzed. The director of said experiment station shall continue to analyze or cause to be analyzed such samples of concentrated commercial feeding stuffs taken under the provisions of this article as shall be submitted to him for that purpose by the commissioner of agriculture and shall report such analyses to the commissioner of agriculture, and for this purpose the New York agricultural experiment station may continue to employ chemists and incur such expenses as may be necessary to comply with the requirements of this article. The result of the analysis of the sample or samples so procured, together with such additional information as circumstances advise, shall be published in reports or bulletins from time to time.

Taking of sample.

Analysis of.

Publication.

§ 165. **Sale of adulterated meal or ground grains.**— No person shall adulterate any kind of meal or ground grain or other cattle food with milling or manufacturing offals, or any substance whatever, for the purpose of sale, unless the true composition, mixture or adulteration thereof is plainly marked or indicated upon the package containing the same or in which it is offered for sale: no person shall sell or offer for sale any meal or ground grain or other cattle food which has been so adulterated unless the true composition, mixture or adulteration is plainly marked or indicated upon the package containing the same, or in which it is offered for sale. (*As amended by chapter* 317 *of the Laws of* 1909.)

PENALTIES.

Section 52 of the Agricultural Law relates to penalties and is as follows:

§ 52. **Penalties.**— Every person violating any of the provisions of this chapter, shall forfeit to the people of the state of New York the sum of not less than fifty dollars nor more than one hundred

dollars for the first violation and not less than one hundred dollars nor more than two hundred dollars for the second and each subsequent violation. When such violation consists of the manufacture or production of any prohibited article, each day during which or any part of which such manufacture or production is carried on or continued, shall be deemed a separate violation. When the violation consists of the sale, or the offering or exposing for sale or exchange of any prohibited article or substance, the sale of each one of several packages shall constitute a separate violation, and each day on which any such article or substance is offered or exposed for sale or exchange shall constitute a separate violation. When the use of any such article or substance is prohibited, each day during which or any part of which said article or substance is so used or furnished for use, shall constitute a separate violation, and the furnishing of the same for use to each person to whom the same may be furnished shall constitute a separate violation. Whoever by himself or another violates any of the provisions of articles three, four, six, eight and nine or sections three hundred fourteen and three hundred fifteen of this chapter or of sections one hundred six, one hundred seven and one hundred eight of this chapter shall be guilty of a misdemeanor, and upon conviction shall be punished by a fine of not less than fifty dollars, nor more than two hundred dollars, or by imprisonment of not less than one month nor more than six months or by both such fine and imprisonment, for the first offense; and by six months' imprisonment for the second offense.

REPORT OF ANALYSES OF SAMPLES OF COMMERCIAL FERTILIZERS COLLECTED BY THE COMMISSIONER OF AGRICULTURE DURING 1912.*

There are presented in this bulletin the analyses† of samples of fertilizers collected by the Commissioner of Agriculture during 1912 and transmitted by him for analysis to the Director of the New York Agricultural Experiment Station, in accordance with the provisions of Article 9 of the Agricultural Law. These analyses and the accompanying information are published by said Director in accordance with the provisions of Section 224 of said Law.

Since many requests have been received for such data, it has been deemed best to give figures showing the current values of fertilizer ingredients, with an illustration of the method of applying these figures in determining the approximate commercial valuation of the different brands.

TRADE-VALUES OF PLANT-FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS.

The trade-values in the following schedule have been agreed upon by the Experiment Stations of Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Vermont, as a result of study of the prices actually prevailing in the large markets of these states.

These trade-values represent, as nearly as can be estimated, the average prices at which, during the six months preceding March, the respective ingredients, *in the form of unmixed raw materials,*

* A reprint of Bulletin No. 354, November, 1912.

† The analyses herewith published are made in charge of the Chemical Department of the Station, the immediate oversight of the work being assigned to E. L. Baker, Associate Chemist.

could be bought at retail for cash in our large markets. These prices also correspond (except in case of available phosphoric acid) to the average wholesale prices for the six months preceding March, plus about 20 per ct., in case of goods for which there are wholesale quotations.

TRADE-VALUES OF PLANT-FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS.

	1912. Cts. per pound.
Nitrogen in ammonia salts	16½
" in nitrates	16½
Organic nitrogen in dry and fine-ground fish, meat and blood	22
" in fine-ground bone, tankage and mixed fertilizers	19
" in coarse bone and tankage	15
" in castor pomace and cottonseed meal	20
Phosphoric acid, water-soluble	4½
" citrate-soluble (reverted)	4
" in fine-ground fish, bone and tankage	4
" in cottonseed meal and castor-pomace	4
" in coarse fish, bone, tankage and ashes	3½
" in mixed fertilizers, insoluble in ammonium citrate or water.	2
Potash as high-grade sulphate, in forms free from muriates (chlorides), in ashes, etc	5¼
" in muriate	4¼
" in castor pomace and cottonseed meal	5

VALUATION AND COST OF FERTILIZERS.

The total cost (to the farmer) of a ton of commercial fertilizer may be regarded as consisting of the following elements: (1) Retail cash cost, in the market, of unmixed trade materials; (2) cost of mixing; (3) cost of transportation; (4) storage, commissions to agents and dealers, selling on long credit, bad debts, etc. While the *total cost* of a fertilizer is made up of several different elements, a *commercial valuation* includes only the first of the elements entering into the total cost, that is, the retail cash cost in the market of unmixed raw materials.

VALUATION AND AGRICULTURAL VALUE.

The *agricultural value* of a fertilizer depends upon its *crop-producing power*. A commercial valuation does not necessarily have any relation to crop-producing value on a given farm. For a particular soil and crop, a fertilizer of comparatively low com-

mercial valuation may have a higher agricultural value; while, for another crop on the same soil, or the same crop on another soil, the reverse might be true.

Rule for Calculating Approximate Commercial Valuation of Mixed Fertilizers on Basis of Trade-Values for 1912.

Multiply the percentage of nitrogen by 3.8.
Multiply the percentage of available phosphoric acid by 0.9.
Multiply the percentage of insoluble phosphoric acid (total minus available) by 0.4.
Multiply the percentage of potash by 1.0.

The sum of these 4 products will be the commercial valuation per ton on the basis taken.

Illustration.—The table of analyses shows a certain fertilizer to have the following composition: Nitrogen 2.52 per ct.; available phosphoric acid 6.31 per ct.; insoluble phosphoric acid .89 per ct.; potash 6.64 per ct. According to this method of valuation, the computation would be as follows:

Nitrogen	2.52 x 3.8	$9.58
Available phosphoric acid	6.31 x 0.9	5.70
Insoluble phosphoric acid	0.89 x 0.4	0.36
Potash	6.64 x 1.0	6.64
		$22.28

This rule assumes all the nitrogen to be organic and all the potash to be in the form of sulphate. If a considerable portion of nitrogen exists in the fertilizer as nitrate of soda or as sulphate of ammonia, and potash is present as muriate, the results are considerably less.

Farmers should be warned against judging fertilizers by their valuations. A fertilizer, the cost of which comes chiefly from the phosphoric acid present, would value much lower commercially than a fertilizer with a high percentage of nitrogen, and yet the former might be the more profitable one for a given farmer to purchase.

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Alexandria Fertilizer & Chem. Co., Alexandria, Va.	Excelsior Guano	Phelps	2969
Alphano Humus Co., Great Meadows, N. J.	Alphano Humus	Mount Vernon	3110
The American Agricultural Chem. Co., New York	Acid Phosphate	Elmira	2038
The American Agricultural Chem. Co., New York	Acid Phosphate	Binghamton	3037
The American Agricultural Chem. Co., New York	Acme Early Crop Producer	Jamaica	2211
The American Agricultural Chem. Co., New York	Acme Fertilizer No. 2	Jamaica	2208
The American Agricultural Chem. Co., New York	Acme No. 1 Potato Manure	Warwick	2296
The American Agricultural Chem. Co., New York	Acme Special Potato and Truck	Laurel	2311
The American Agricultural Chem. Co., New York	Acme Superior Superphosphate	Apalachin	2811
The American Agricultural Chem. Co., New York	Bone Meal	Cornwall Landing	2719
The American Agricultural Chem. Co., New York	Bradley's Alkaline Bone with Potash	Cobleskill	2739
The American Agricultural Chem. Co., New York	Bradley's Ammoniated Dissolved Bone	Skaneateles	2429
The American Agricultural Chem. Co., New York	Bradley's Bean and Potato Phosphate	Skaneateles	2431
The American Agricultural Chem. Co., New York	Bradley's B. D. Sea Fowl Guano	Middleburg	2729
The American Agricultural Chem. Co., New York	Bradley's "B" Fertilizer	Owego	2502
The American Agricultural Chem. Co., New York	Bradley's Complete Manure for Potatoes and Vegetables	Riverhead	2303

COLLECTED IN NEW YORK STATE IN 1912

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2969	Guaranteed Found	.82 1.07	9. 9.76	——— 10.80	7. 7.48
3110	Guaranteed Found	——— .97	——— ———	——— .85	——— .54
2038	Guaranteed Found	——— ———	14. 15.12	15. 15.90	——— ———
3037	Guaranteed Found	——— ———	14. 15.56	15. 16.10	——— ———
2211	Guaranteed Found	4.11 4.26	8. 8.53	9. 9.38	7. 6.83
2208	Guaranteed Found	4.94 5.04	8. 8.35	9. 9.28	5. 5.08
2296	Guaranteed Found	3.29 3.12	6. 6.96	7. 7.78	10. 10.86
2311	Guaranteed Found	3.29 3.33	8. 8.06	9. 8.78	7. 7.44
2811	Guaranteed Found	.82 1.03	8. 8.43	9. 10.	4. 4.14
2719	Guaranteed Found	1.65 1.95	——— ———	13.75 14.65	——— ———
2739	Guaranteed Found	——— ———	11. 11.05	12. 11.37	2. 2.32
2429	Guaranteed Found	1.65 1.68	8. 8.71	9. 9.78	2. 2.18
2431	Guaranteed Found	.82 .92	8. 8.10	9. 9.52	4. 4.30
2729	Guaranteed Found	2.06 2.06	8. 8.46	9. 10.34	1.50 1.78
2502	Guaranteed Found	.82 .88	8. 7.95	9. 9.51	4. 3.90
2303	Guaranteed Found	3.29 3.28	8. 8.47	9. 9.23	7. 7.24

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Bradley's Complete Manure with 10% Potash	Riverhead	2304
The American Agricultural Chem. Co., New York	Bradley's Justice Dissolved Bone	Esperance	2725
The American Agricultural Chem. Co., New York	Bradley's New Method Fertilizer	Catskill	2256
The American Agricultural Chem. Co., New York	Bradley's Niagara Phosphate	Skaneateles	2432
The American Agricultural Chem. Co., New York	Bradley's Patent Super-Phosphate	Skaneateles	2427
The American Agricultural Chem. Co., New York	Bradley's Potato and Truck Grower	Catskill	2254
The American Agricultural Chem. Co., New York	Bradley's Potato Fertilizer	Owego	2503
The American Agricultural Chem. Co., New York	Bradley's Potato Manure	Owego	2504
The American Agricultural Chem. Co., New York	Bradley's Soluble Dissolved Phosphate	Skaneateles	2430
The American Agricultural Chem. Co., New York	Canner's Pea and Bean Special Fertilizer	Cortland	2525
The American Agricultural Chem. Co., New York	Chicopee Farmers Reliable	Cherry Valley	2742
The American Agricultural Chem. Co., New York	Chicopee Standard Guano	Ballston Spa.	2852
The American Agricultural Chem. Co., New York	Chicopee Vegetable and Potato Manure	White Plains	3107
The American Agricultural Chem. Co., New York	Clark's Cove Atlas Phosphate	Delanson	2280
The American Agricultural Chem. Co., New York	Clark's Cove Defiance Fertilizer	Orchard Park	2610
The American Agricultural Chem. Co., New York	Clark's Cove King Philip Alkaline Guano	Delanson	2281
The American Agricultural Chem. Co., New York	Clark's Cove Potato and Hop Grower	Port Jervis	2712

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric Acid. Available.	Phosphoric Acid. Total.	Potash.
2304	Guaranteed Found	3.29 3.36	6. 6.74	7. 7.31	10. 10.76
2725	Guaranteed Found	—— ——	12. 12.41	13. 13.58	—— ——
2256	Guaranteed Found	.82 .90	8. 8.34	9. 9.65	2. 2.10
2432	Guaranteed Found	.82 .96	7. 6.98	8. 8.74	1. 1.28
2427	Guaranteed Found	2.06 1.88	8. 8.32	9. 10.69	1.50 2.38
2254	Guaranteed Found	1.65 1.64	8. 8.45	9. 9.63	10. 10.26
2503	Guaranteed Found	2.06 2.04	8. 7.93	9. 9.37	3. 3.26
2504	Guaranteed Found	2.47 2.48	6. 6.64	7. 7.84	6. 5.85
2430	Guaranteed Found	—— ——	14. 14.83	15. 15.36	—— ——
2525	Guaranteed Found	.82 1.01	7. 7.74	8. 9.06	9. 8.10
2742	Guaranteed Found	.82 .83	7. 7.65	8. 9.	1. 1.54
2852	Guaranteed Found	.82 .94	8. 8.50	9. 9.21	4. 4.44
3107	Guaranteed Found	2.47 2.27	8. 8.49	9. 9.72	6. 5.56
2280	Guaranteed Found	—— ——	14. 14.69	15. 15.20	—— ——
2610	Guaranteed Found	.82 .96	7. 7.45	8. 9.55	1. 1.42
2281	Guaranteed Found	1.03 1.33	8. 8.39	9. 9.97	2. 2.16
2712	Guaranteed Found	.82 1.03	8. 8.38	9. 9.55	4. 4.14

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Clark's Cove Triumph Phosphate and Potash	Delanson	2283
The American Agricultural Chem. Co., New York	Clark's Cove Unicorn Fertilizer	Guilford	2526
The American Agricultural Chem. Co., New York	Complete Tobacco Manure	Owego	2845
The American Agricultural Chem. Co., New York	Crocker's Alkaline Bone and Potash	Auburn	2552
The American Agricultural Chem. Co., New York	Crocker's Cabbage and Potato Manure	Seneca Falls	2582
The American Agricultural Chem. Co., New York	Crocker's Complete Manure	Albion	2126
The American Agricultural Chem. Co., New York	Crocker's Complete Wheat Grower	Albion	2124
The American Agricultural Chem. Co., New York	Crocker's Dissolved Phosphate	Sherburne	2532
The American Agricultural Chem. Co., New York	Crocker's Dissolved Phosphate and Potash	Waverly	2563
The American Agricultural Chem. Co., New York	Crocker's Erie Phosphate	Sherburne	2533
The American Agricultural Chem. Co., New York	Crocker's General Crop Fertilizer	Hamburg	2616
The American Agricultural Chem. Co., New York	Crocker's Harvest Jewel Fertilizer	Hamburg	2615
The American Agricultural Chem. Co., New York	Crocker's High Grade Special Fertilizer	Albion	2125
The American Agricultural Chem. Co., New York	Crocker's New Rival Fertilizer	Groton	2506
The American Agricultural Chem. Co., New York	Crocker's New York Special Phosphate	Albion	2128
The American Agricultural Chem. Co., New York	Crocker's Potato, Hop and Tobacco Fertilizer	Waverly	2562

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
2283	Guaranteed Found	—— ——	10. 10.51	11. 11.35	2. 2.04
2526	Guaranteed Found	1.65 1.57	8. 8.23	9. 9.42	2. 2.04
2845	Guaranteed Found	4.53 5.06	3. 3.90	4. 5.60	5.50 5.16
2552	Guaranteed Found	—— ——	12. 12.68	13. 13.18	5. 5.12
2582	Guaranteed Found	2.47 2.40	8. 8.83	9. 10.76	6. 5.56
2126	Guaranteed Found	.82 .98	8. 8.67	9. 10.38	4. 3.86
2124	Guaranteed Found	1.65 .91	10. 11.09	11. 13.24	4. 2.54
2532	Guaranteed Found	—— ——	14. 15.41	15. 15.65	—— ——
2563	Guaranteed Found	—— ——	10. 10.59	11. 11.51	2. 2.10
2533	Guaranteed Found	—— ——	12. 14.29	13. 15.13	—— ——
2616	Guaranteed Found	.82 .90	7. 6.44	8. 8.69	1. 1.22
2615	Guaranteed Found	1.65 1.68	8. 7.99	9. 10.39	2. 2.32
2125	Guaranteed Found	1.65 1.50	8. 9.16	9. 10.72	4. 4.22
2506	Guaranteed Found	1.23 1.38	9. 9.72	10. 11.13	2. 2.78
2128	Guaranteed Found	—— ——	10. 11.08	11. 12.67	8. 7.82
2562	Guaranteed Found	2.06 2.02	8. 8.17	9. 9.05	3. 3.32

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Crocker's Special Potato Manure	Mattituck	2383
The American Agricultural Chem. Co., New York	Crocker's Universal Grain Grower	Boonville	2685
The American Agricultural Chem. Co., New York	Crocker's Wheat and Corn Fertilizer	Albion	2127
The American Agricultural Chem. Co., New York	Darling's Blood, Bone and Potash	Laurel	2312
The American Agricultural Chem. Co., New York	Darling's Long Island "A"	Mattituck	2377
The American Agricultural Chem. Co., New York	Dry Ground Fish	Mattituck	2350
The American Agricultural Chem. Co., New York	East India Complete Manure for General Use	Catskill	2255
The American Agricultural Chem. Co., New York	East India Corn, Cabbage and Potato Manure	Monroe	2701
The American Agricultural Chem. Co., New York	East India H. G. General Fertilizer	New Hyde Park	1788
The American Agricultural Chem. Co., New York	East India Nitrogenized Complete Manure	Stuyvesant Falls	3130
The American Agricultural Chem. Co., New York	East India Potato Manure	New Hyde Park	2217
The American Agricultural Chem. Co., New York	East India Potato and Truck Manure	Mattituck	2351
The American Agricultural Chem. Co., New York	East India Vegetable, Vine and Potato Manure	Binghamton	2043
The American Agricultural Chem. Co., New York	Fine Ground Bone	Brockport	2465
The American Agricultural Chem. Co., New York	Genuine German Kainit	Mattituck	2352
The American Agricultural Chem. Co., New York	Grass and Lawn Top Dressing	Warwick	2297
The American Agricultural Chem. Co., New York	Great Eastern English Wheat Grower	Unadilla	2592

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2383	Guaranteed Found	3.29 3.15	8. 8.45	9. 9.08	7. 7.44
2685	Guaranteed Found	.82 .92	8. 8.40	9. 9.57	2. 2.22
2127	Guaranteed Found	2.06 2.06	8. 8.90	9. 10.37	1.50 2.70
2312	Guaranteed Found	4.11 4.11	7. 7.44	8. 8.30	7. 7.54
2377	Guaranteed Found	3.29 3.47	8. 8.35	9. 9.19	7. 6.90
2350	Guaranteed Found	8.23 7.83	—— ——	6. 7.40	—— ——
2255	Guaranteed Found	2.47 2.67	8. 8.62	9. 10.30	6. 6.12
2701	Guaranteed Found	4.11 4.11	7. 7.85	8. 8.45	7. 7.36
1788	Guaranteed Found	3.29 3.36	8. 8.29	9. 9.10	7. 7.20
3130	Guaranteed Found	8.23 8.30	4. 5.50	5. 6.64	4. 4.20
2217	Guaranteed Found	3.29 3.32	6. 6.22	7. 6.95	10. 10.48
2351	Guaranteed Found	3.29 3.42	7. 7.14	8. 7.88	7. 7.32
2043	Guaranteed Found	2.47 2.56	6. 6.99	7. 9.26	10. 10.24
2465	Guaranteed Found	2.47 3.21	—— ——	22.88 23.49	—— ——
2352	Guaranteed Found	—— ——	—— ——	—— ——	12. 13.52
2297	Guaranteed Found	3.91 3.64	5. 5.31	6. 7.25	2. 2.68
2592	Guaranteed Found	.82 1.01	8. 8.22	9. 9.24	2. 2.16

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Great Eastern Garden Special	Jamaica	2210
The American Agricultural Chem. Co., New York	Great Eastern Garden Special	Orient	2660
The American Agricultural Chem. Co., New York	Great Eastern General	Delanson	2277
The American Agricultural Chem. Co., New York	Great Eastern High Grade Vegetable, Vine and Tobacco Fertilizer	Unadilla	2591
The American Agricultural Chem. Co., New York	Great Eastern New York Potato Special	Chateaugay	2911
The American Agricultural Chem. Co., New York	Great Eastern Northern Corn Special	Unadilla	2590
The American Agricultural Chem. Co., New York	Great Eastern Peerless Potato Manure	Delanson	2278
The American Agricultural Chem. Co., New York	Great Eastern Schodack Special	Gouverneur	2676
The American Agricultural Chem. Co., New York	Great Eastern Soluble Bone and Potash	Sherburne	2530
The American Agricultural Chem. Co., New York	Great Eastern Unammoniated Wheat Special	Sherburne	2531
The American Agricultural Chem. Co., New York	Great Eastern Vegetable, Vine and Tobacco Fertilizer	Burke	2910
The American Agricultural Chem. Co., New York	Ground Tankage	Oakfield	2771
The American Agricultural Chem. Co., New York	Ground Tankage 9–20	Oneida	2825
The American Agricultural Chem. Co., New York	Ground Untreated Phosphate Rock	Barneveld	2698
The American Agricultural Chem. Co., New York	High Grade Celery, Onion and Truck Manure	Jamaica	2215
The American Agricultural Chem. Co., New York	High Grade Dried Blood	Elmira	2036

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2210	Guaranteed Found	3.29 3.32	8. 8.37	9. 9.	7. 7.24
2660	Guaranteed Found	3.29 3.21	8. 8.73	9. 9.04	7. 7.42
2277	Guaranteed Found	.82 .86	8. 8.18	9. 8.98	4. 4.38
2591	Guaranteed Found	2.06 2.10	8. 8.73	9. 9.39	6. 5.96
2911	Guaranteed Found	1.85 1.63	7. 7.95	8. 9.12	10. 9.02
2590	Guaranteed Found	2.47 2.68	9. 9.18	10. 10.63	2. 2.12
2278	Guaranteed Found	1.03 1.26	7. 7.51	8. 9.10	10. 10.26
2676	Guaranteed Found	.82 .87	9. 9.97	10. 10.59	7. 7.20
2530	Guaranteed Found	—— ——	11. 11.12	12. 11.38	2. 2.08
2531	Guaranteed Found	—— ——	12. 12.27	13. 12.96	—— ——
2910	Guaranteed Found	2.06 2.06	8. 7.69	9. 9.63	3. 3.22
2771	Guaranteed Found	7.40 6.99	—— ——	9.15 11.30	—— ——
2825	Guaranteed Found	7.41 7.11	—— ——	9.15 11.38	—— ——
2698	Guaranteed Found	—— ——	—— ——	30.20 30.70	—— ——
2215	Guaranteed Found	4.11 3.41	4. 4.84	5. 5.37	12. 11.46
2036	Guaranteed Found	9.87 12.24	—— ——	—— ——	—— ——

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	High Grade Ground Bone	Elmira	3015
The American Agricultural Chem. Co., New York	High Grade Potash Compound	Randolph	2109
The American Agricultural Chem. Co., New York	High Grade Sulphate of Potash	Elmira	3014
The American Agricultural Chem. Co., New York	Lazaretto "AA" Superphosphate	Webster	3176
The American Agricultural Chem. Co., New York	Lazaretto Alkaline Dissolved Bone	Smithboro	3006
The American Agricultural Chem. Co., New York	Lazaretto Ammoniated Phosphate	Carlton Station	2981
The American Agricultural Chem. Co., New York	Lazaretto Dissolved Phosphate	Cortland	3038
The American Agricultural Chem. Co., New York	Lazaretto Dissolved Phosphate and Potash	Ballston Spa	2853
The American Agricultural Chem. Co., New York	Lazaretto Extra Ammoniated Bone Phosphate	Medina	2455
The American Agricultural Chem. Co., New York	Lazaretto High Grade Alkaline Dissolved Bone	Medina	2456
The American Agricultural Chem. Co., New York	Lazaretto New York Standard No. 1	Copenhagen	2682
The American Agricultural Chem. Co., New York	Michigan Carbon Works General Crop Fertilizer	Middleport	2489
The American Agricultural Chem. Co., New York	Michigan Carbon Works Homestead Fertilizer	North Collins	2627
The American Agricultural Chem. Co., New York	Michigan Carbon Works Homestead Potato and Tobacco Fertilizer	Middleport	2490
The American Agricultural Chem. Co., New York	Michigan Carbon Works Red Line Phosphate	Fredonia	2965
The American Agricultural Chem. Co., New York	Michigan Carbon Works Red Line Phosphate with Potash	Ellicottville	3178

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
3015	Guaranteed Found	3.29 3.97	—— ——	20.59 20.73	—— ——
2109	Guaranteed Found	1.65 1.70	8. 8.06	9. 10.04	10. 10.06
3014	Guaranteed Found	—— ——	—— ——	—— ——	48. 45.88
3176	Guaranteed Found	1.85 1.77	9. 9.65	10. 11.	4. 4.48
3006	Guaranteed Found	—— ——	13. 13.23	14. 13.60	3. 3.40
2981	Guaranteed Found	.82 1.	8. 8.40	9. 10.68	2. 2.34
3038	Guaranteed Found	—— ——	14. 14.45	15. 16.	—— ——
2853	Guaranteed Found	—— ——	10. 10.46	11. 11.08	2. 2.10
2455	Guaranteed Found	.83 .97	8. 8.18	9. 9.85	4. 3.96
2456	Guaranteed Found	—— ——	10. 10.25	11. 11.95	8. 7.52
2682	Guaranteed Found	1.65 1.43	8. 8.98	9. 9.62	2. 2.42
2489	Guaranteed Found	.82 .95	8. 8.94	9. 9.89	4. 4.24
2627	Guaranteed Found	2.06 2.14	8. 8.76	9. 10.56	1.50 2.
2490	Guaranteed Found	2.06 2.13	8. 8.64	9. 9.81	3. 3.18
2965	Guaranteed Found	—— ——	14. 13.66	15. 15.95	—— ——
3178	Guaranteed Found	—— ——	10. 10.38	11. 11.98	2. 1.90

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Milsom's Acid Phosphate	Albion	2130
The American Agricultural Chem. Co., New York	Milsom's Acidulated Bone and Potash	Romulus	2572
The American Agricultural Chem. Co., New York	Milsom's Blood, Bone and Potash Fertilizer	McGraw	2546
The American Agricultural Chem. Co., New York	Milsom's Buffalo Fertilizer	Canandaigua	2792
The American Agricultural Chem. Co., New York	Milsom's Buffalo Guano	Fancher	2140
The American Agricultural Chem. Co., New York	Milsom's Corn Fertilizer	Chenango Forks	2439
The American Agricultural Chem. Co., New York	Milsom's Dissolved Phosphate	Fancher	2145
The American Agricultural Chem. Co., New York	Milsom's Dissolved Phosphate and Potash	Trumansburg	2566
The American Agricultural Chem. Co., New York	Milsom's Erie King Fertilizer	Clarence	2777
The American Agricultural Chem. Co., New York	Milsom's Potato and Cabbage Manure	Albion	2132
The American Agricultural Chem. Co., New York	Milsom's Potato, Hop and Tobacco Fertilizer	Chenango Forks	2438
The American Agricultural Chem. Co., New York	Milsom's Special Bean and Grain Fertilizer	Albion	2129
The American Agricultural Chem. Co., New York	Milsom's Vegetable Fertilizer	Hamburg	2625
The American Agricultural Chem. Co., New York	Milsom's Vegetable Fertilizer	North Collins	2630
The American Agricultural Chem. Co., New York	Milsom's Wheat, Oats and Barley Fertilizer	Randolph	2110
The American Agricultural Chem. Co., New York	Muriate of Potash	Elmira	2037
The American Agricultural Chem. Co., New York	Muriate of Potash	Gates	2759

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
2130	Guaranteed Found	—— ——	14. 13.50	15. 15.72	—— ——
2572	Guaranteed Found	—— ——	12. 12.43	13. 12.68	5. 4.98
2546	Guaranteed Found	3.29 3.24	6. 6.45	7. 6.92	10. 10.46
2792	Guaranteed Found	2.06 2.10	8. 8.59	9. 9.98	1.50 1.64
2140	Guaranteed Found	.82 .98	8. 8.31	9. 10.12	4. 3.78
2439	Guaranteed Found	2.47 2.42	9. 9.54	10. 10.49	2. 2.88
2145	Guaranteed Found	—— ——	12. 11.74	13. 14.17	—— ——
2566	Guaranteed Found	—— ——	10. 10.14	11. 10.93	2. 2.12
2777	Guaranteed Found	.82 1.12	7. 7.	8. 9.47	1. 1.40
2132	Guaranteed Found	.82 1.	9. 9.12	10. 11.32	7. 7.64
2438	Guaranteed Found	2.06 1.96	8. 8.14	9. 9.32	3. 3.70
2129	Guaranteed Found	—— ——	10. 10.33	11. 12.09	8. 7.58
2625	Guaranteed Found	3.29 3.33	8. 8.44	9. 8.85	7. 7.64
2630	Guaranteed Found	3.29 3.24	8. 8.91	9. 10.38	7. 7.82
2110	Guaranteed Found	.82 1.18	8. 7.97	9. 10.32	2. 2.58
2037	Guaranteed Found	—— ——	—— ——	—— ——	49. 49.80
2759	Guaranteed Found	—— ——	—— ——	—— ——	49. 50.36

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Nitrate of Soda	Elmira	2039
The American Agricultural Chem. Co., New York	Nitrate of Soda	Gates	2760
The American Agricultural Chem. Co., New York	Nitrate of Soda	Ogdensburg	2905
The American Agricultural Chem. Co., New York	North Western Acid Phosphate	Medina	2150
The American Agricultural Chem. Co., New York	North Western Acid Phosphate	Rochester	2758
The American Agricultural Chem. Co., New York	North Western Beet Special Fertilizer	Syracuse	2824
The American Agricultural Chem. Co., New York	North Western Challenge Crop Grower	Potsdam	2671
The American Agricultural Chem. Co., New York	North Western Complete Compound	Voorheesville	2271
The American Agricultural Chem. Co., New York	North Western Dissolved Phosphate and Potash	Voorheesville	2273
The American Agricultural Chem. Co., New York	North Western Empire Special Manure	Highland	3121
The American Agricultural Chem. Co., New York	North Western Grain Fertilizer	North Harpersfield	2837
The American Agricultural Chem. Co., New York	North Western High Grade Alkaline Phosphate	Greene	2537
The American Agricultural Chem. Co., New York	North Western High Grade General Fertilizer	Medina	2454
The American Agricultural Chem. Co., New York	North Western Market Garden Phosphate	Darien	3151
The American Agricultural Chem. Co., New York	North Western Special Fertilizer	Medina	2457
The American Agricultural Chem. Co., New York	North Western 10% Potato Fertilizer	Medina	2453

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
2039	Guaranteed Found	15. 15.76	—— ——	—— ——	—— ——
2760	Guaranteed Found	15. 14.99	—— ——	—— ——	—— ——
2905	Guaranteed Found	15. 15.05	—— ——	—— ——	—— ——
2150	Guaranteed Found	—— ——	14. 14.29	15. 16.76	—— ——
2758	Guaranteed Found	—— ——	14. 14.20	15. 16.90	—— ——
2824	Guaranteed Found	.82 1.16	8. 8.57	9. 9.55	10. 8.45
2671	Guaranteed Found	1.03 1.27	8. 8.50	9. 9.56	2. 2.46
2271	Guaranteed Found	.82 .88	8. 8.26	9. 9.67	4. 4.06
2273	Guaranteed Found	—— ——	10. 10.13	11. 11.17	2. 2.02
3121	Guaranteed Found	3.29 3.56	7. 8.14	8. 8.80	7. 6.16
2837	Guaranteed Found	1.65 1.64	10. 11.17	11. 11.99	4. 3.90
2537	Guaranteed Found	—— ——	10. 10.93	11. 11.57	8. 7.92
2454	Guaranteed Found	1.65 1.79	8. 8.68	9. 10.16	4. 4.28
3151	Guaranteed Found	2.47 2.40	8. 8.87	9. 10.38	6. 5.86
2457	Guaranteed Found	.82 1.06	9. 9.02	10. 11.25	7. 6.96
2453	Guaranteed Found	1.65 1.55	8. 8.39	9. 10.28	10. 10.68

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	North Western XXX Alkaline Phosphate	Cherry Valley	2746
The American Agricultural Chem. Co., New York	Pacific Nobsque Guano	Eden Center	2620
The American Agricultural Chem. Co., New York	Pacific Soluble Guano	Moravia	2508
The American Agricultural Chem. Co., New York	Packer's Union Animal Corn Fertilizer	Afton	2844
The American Agricultural Chem. Co., New York	Packer's Union Banner Wheat Grower	Schuylerville	2870
The American Agricultural Chem. Co., New York	Packer's Union Gardeners Complete Manure	East Marion	2399
The American Agricultural Chem. Co., New York	Packer's Union Potato Manure	East Marion	2400
The American Agricultural Chem. Co., New York	Packer's Union Universal Fertilizer	Lowville	2684
The American Agricultural Chem. Co., New York	Potato and Garden Manure	Little Neck	2242
The American Agricultural Chem. Co., New York	Potato and Onion Special	Albion	2131
The American Agricultural Chem. Co., New York	Preston's Pioneer Fertilizer	Tivoli	3123
The American Agricultural Chem. Co., New York	Preston's Potato Fertilizer	Valley Stream	2237
The American Agricultural Chem. Co., New York	Pulverized Sheep Manure	Jamaica	1786
The American Agricultural Chem. Co., New York	Pure Ground Bone	Hamburg	2626
The American Agricultural Chem. Co., New York	Pure Unleached Canada Hardwood Ashes	New York	2247
The American Agricultural Chem. Co., New York	Quinnipiac Ammoniated Dissolved Bone	Skaneateles	2407
The American Agricultural Chem. Co., New York	Quinnipiac "B" Fertilizer	Trumansburg	2565

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2746	Guaranteed Found	—— ——	10. 10.08	11. 10.44	5. 5.76
2620	Guaranteed Found	1.03 1.35	8. 8.15	9. 10.26	2. 2.66
2508	Guaranteed Found	2.06 2.07	8. 7.89	9. 9.61	1.50 1.92
2844	Guaranteed Found	2.47 2.61	9. 9.08	10. 10.71	2. 2.38
2870	Guaranteed Found	—— ——	10. 10.71	11. 11.14	2. 2.10
2399	Guaranteed Found	3.29 3.38	6. 6.29	7. 6.90	10. 10.20
2400	Guaranteed Found	2.06 2.37	8. 8.41	9. 9.38	6. 6.16
2684	Guaranteed Found	.82 .97	8. 8.53	9. 9.38	4. 4.48
2242	Guaranteed Found	3.29 3.22	7. 7.30	8. 8.20	7. 7.10
2131	Guaranteed Found	1.65 1.72	10. 10.26	11. 12.05	6. 5.96
3123	Guaranteed Found	1.03 1.17	8. 8.52	9. 10.72	2. 2.32
2237	Guaranteed Found	3.29 3.52	8. 8.15	9. 8.95	7. 7.08
1786	Guaranteed Found	2.06 2.25	.50 1.14	1.25 1.24	.50 2.04
2626	Guaranteed Found	3.29 3.28	—— ——	20.59 22.29	—— ——
2247	Guaranteed Found	—— ——	—— .53	—— 1.11	2. 3.12
2407	Guaranteed Found	1.65 1.57	8. 8.23	9. 9.44	2. 2.26
2565	Guaranteed Found	.82 .93	8. 8.33	9. 8.90	4. 4.34

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Quinnipiac Climax Phosphate	Skaneateles	2410
The American Agricultural Chem. Co., New York	Quinnipiac Dissolved Phosphate and Potash	Newark Valley	3007
The American Agricultural Chem. Co., New York	Quinnipiac Market Garden Manure	Fort Johnson	2855
The American Agricultural Chem. Co., New York	Quinnipiac Mohawk Fertilizer	Skaneateles	2409
The American Agricultural Chem. Co., New York	Quinnipiac Potato Manure	Preble	2550
The American Agricultural Chem. Co., New York	Quinnipiac Potato Phosphate	Fort Johnson	2856
The American Agricultural Chem. Co., New York	Quinnipiac Soluble Dissolved Phosphate	Skaneateles	2408
The American Agricultural Chem. Co., New York	Read's Acid Phosphate	Willow Creek	2570
The American Agricultural Chem. Co., New York	Read's Corn, Wheat and Rye Fertilizer	Windsor	2177
The American Agricultural Chem. Co., New York	Read's Dissolved Bone	Eden Center	2619
The American Agricultural Chem. Co., New York	Read's Farmer's Friend Super Phosphate	Greenwood Lake	2298
The American Agricultural Chem. Co., New York	Read's High Grade Farmer's Friend	Lynbrook	1789
The American Agricultural Chem. Co., New York	Read's High Grade Farmer's Friend	Medina	2452
The American Agricultural Chem. Co., New York	Read's High Grade Farmer's Friend	Medina	3251
The American Agricultural Chem. Co., New York	Read's High Grade Special	Middleport	2488
The American Agricultural Chem. Co., New York	Read's Leader B and B Fertilizer	Potsdam	2675
The American Agricultural Chem. Co., New York	Read's Phosphate and Potash	Willow Creek	2571

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric Acid. Available.	Phosphoric Acid. Total.	Potash.
2410	Guaranteed Found	1.03 1.20	8. 8.70	9. 9.87	2. 2.40
3007	Guaranteed Found	—— ——	10. 10.62	11. 11.40	2. 2.10
2855	Guaranteed Found	3.29 3.56	8. 8.60	9. 9.21	7. 7.72
2409	Guaranteed Found	.82 .95	7. 7.29	8. 8.39	1. 1.22
2550	Guaranteed Found	2.47 2.56	6. 6.99	7. 7.87	6. 5.73
2856	Guaranteed Found	2.06 2.14	8. 7.99	9. 9.84	3. 3.42
2408	Guaranteed Found	—— ——	14. 14.83	15. 15.99	—— ——
2570	Guaranteed Found	—— ——	14. 13.88	15. 14.58	—— ——
2177	Guaranteed Found	1.65 2.44	8. 8.30	9. 9.17	4. 5.14
2619	Guaranteed Found	—— ——	12. 11.77	13. 13.76	—— ——
2298	Guaranteed Found	2.06 2.10	8. 8.22	9. 9.40	3. 3.44
1789	Guaranteed Found	3.29 3.36	6. 6.84	7. 7.38	10. 10.38
2452	Guaranteed Found	3.29 2.49	6. 7.33	7. 8.72	10. 10.96
3251	Guaranteed Found	3.29 3.08	6. 6.69	7. 8.15	10. 10.20
2488	Guaranteed Found	—— ——	12. 12.06	13. 13.53	5. 5.30
2675	Guaranteed Found	.82 .92	7. 8.11	8. 9.23	1. 1.18
2571	Guaranteed Found	—— ——	10. 11.08	11. 12.29	2. 1.76

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Read's Practical Potato Special	Windsor	2175
The American Agricultural Chem. Co., New York	Read's Standard Super Phosphate	Windsor	2174
The American Agricultural Chem. Co., New York	Read's 10 and 8	Windsor	2176
The American Agricultural Chem. Co., New York	Read's Truck Fertilizer	Lynbrook	1790
The American Agricultural Chem. Co., New York	Read's Vegetable and Vine Fertilizer	Lynbrook	1791
The American Agricultural Chem. Co., New York	Read's Veribest	East Homer	3039
The American Agricultural Chem. Co., New York	Reese's Challenge Crop Grower	Kirkwood	2807
The American Agricultural Chem. Co., New York	Reese's Crown Phosphate and Potash	West Stockholm	2914
The American Agricultural Chem. Co., New York	Reese's Elm Phosphate	West Stockholm	2915
The American Agricultural Chem. Co., New York	Reese's High Grade Potash Mixture	Skaneateles	2411
The American Agricultural Chem. Co., New York	Reese's Mayflower	Kirkwood	2809
The American Agricultural Chem. Co., New York	Reese's Pilgrim Fertilizer	West Stockholm	2913
The American Agricultural Chem. Co., New York	Reese's Potato Manure	Kirkwood	2808
The American Agricultural Chem. Co., New York	Reese's Special Alkaline Phosphate	West Stockholm	2912
The American Agricultural Chem. Co., New York	16% Acid Phosphate	Riverhead	2336
The American Agricultural Chem. Co., New York	Special Potash Mixture	So. Alabama	2769
The American Agricultural Chem. Co., New York	Standard "A" Fertilizer	Sharon Springs	2750

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2175	Guaranteed Found	.82 .89	4. 5.02	5. 6.48	8. 8.62
2174	Guaranteed Found	.82 .85	8. 7.98	9. 8.93	4. 4.88
2176	Guaranteed Found	—— ——	10. 9.97	11. 10.82	8. 8.30
1790	Guaranteed Found	3.29 3.30	8. 8.57	9. 9.27	7. 7.52
1791	Guaranteed Found	2.06 2.30	8. 8.45	9. 9.54	3. 6.04
3039	Guaranteed Found	1.65 1.96	10. 10.38	11. 10.90	8. 8.14
2807	Guaranteed Found	.82 1.06	8. 8.25	9. 9.73	2. 2.76
2914	Guaranteed Found	—— ——	11. 11.35	12. 12.05	2. 2.38
2915	Guaranteed Found	—— ——	14. 13.78	15. 15.49	—— ——
2411	Guaranteed Found	—— ——	12. 11.66	13. 12.04	5. 5.32
2809	Guaranteed Found	1.65 1.84	8. 8.58	9. 9.67	2. 4.38
2913	Guaranteed Found	.82 .90	8. 7.87	9. 9.15	4. 4.10
2808	Guaranteed Found	.82 .98	9. 9.29	10. 9.99	7. 6.80
2912	Guaranteed Found	—— ——	10. 10.	11. 11.44	2. 1.92
2336	Guaranteed Found	—— ——	—— 16.14	—— 16.80	—— ——
2769	Guaranteed Found	.82 1.20	9. 9.32	10. 11.44	7. 7.08
2750	Guaranteed Found	.82 .88	7. 7.07	8. 8.79	1. 1.22

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Standard Ammoniated Dissolved Bone	Akron	2774
The American Agricultural Chem. Co., New York	Standard "B" Fertilizer	Fonda	2851
The American Agricultural Chem. Co., New York	Stardard Complete Manure	Orchard Park	2609
The American Agricultural Chem. Co., New York	Standard Guano	Cornwallville	2262
The American Agricultural Chem. Co., New York	Standard Phosphate and Potash	Cornwallville	2260
The American Agricultural Chem. Co., New York	Standard Special for Potatoes	Cornwallville	2261
The American Agricultural Chem. Co., New York	Suffolk County Club's Cauliflower Fertilizer	Mattituck	2662
The American Agricultural Chem. Co., New York	Suffolk County Club's Fertilizer	Mattituck	2661
The American Agricultural Chem. Co., New York	Sulphate of Ammonia	Oneida	2826
The American Agricultural Chem. Co., New York	Superior Alkaline Bone	Fancher	2142
The American Agricultural Chem. Co., New York	10% Vegetable and Potato Manure	Kingston	2265
The American Agricultural Chem. Co., New York	Thomas Phosphate Powder (Basic Slag)	Binghamton	3036
The American Agricultural Chem. Co., New York	Wheat & Corn Producer	Port Jervis	2711
The American Agricultural Chem. Co., New York	Wheeler's Corn Fertilizer	Sherburne	2534
The American Agricultural Chem. Co., New York	Wheeler's Fruit and Grain Grower	Delanson	2279
The American Agricultural Chem. Co., New York	Wheeler's High Grade Phosphate and Potash	Apulia	2548
The American Agricultural Chem. Co., New York	Wheeler's Peerless Acid Phosphate	Delanson	2723

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric Acid.		
		Nitrogen.	Available.	Total.	Potash.
2774	Guaranteed Found	1.65 1.87	8. 8.69	9. 10.93	2. 2.38
2851	Guaranteed Found	.82 .97	8. 9.37	9. 9.93	4. 6.58
2609	Guaranteed Found	3.29 3.21	8. 8.67	9. 10.69	7. 6.72
2262	Guaranteed Found	1.03 1.20	8. 8.54	9. 10.13	2. 2.26
2260	Guaranteed Found	——— ———	10. 10.65	11. 11.48	2. 2.12
2261	Guaranteed Found	2.06 2.19	8. 8.23	9. 9.08	3. 3.44
2662	Guaranteed Found	4.94 5.	8. 8.44	9. 9.61	5. 4.88
2661	Guaranteed Found	4.11 4.14	8. 8.42	9. 10.10	8. 8.32
2826	Guaranteed Found	20.16 20.69	——— ———	——— ———	——— ———
2142	Guaranteed Found	——— ———	10. 9.45	11. 11.39	5. 5.18
2265	Guaranteed Found	1.65 1.67	8. 8.04	9. 9.68	10. 10.84
3036	Guaranteed Found	——— ———	——— ———	16. 16.73	——— ———
2711	Guaranteed Found	1.24 1.38	9. 9.21	11. 10.53	2. 2.42
2534	Guaranteed Found	1.65 1.81	8. 8.37	9. 9.77	2. 1.98
2279	Guaranteed Found	——— ———	10. 10.30	11. 10.93	8. 8.22
2548	Guaranteed Found	——— ———	12. 12.27	13. 12.51	5. 4.94
2723	Guaranteed Found	——— ———	14. 15.33	15. 15.79	——— ———

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Wheeler's Potato Manure	Freeport	1799
The American Agricultural Chem. Co., New York	Wheeler's Royal Wheat Grower	Holcomb	3183
The American Agricultural Chem. Co., New York	Wheeler's Superior Truck	Easthampton	2670
The American Agricultural Chem. Co., New York	Wheeler's Wheat and Clover Fertilizer	Apulia	2547
The American Agricultural Chem. Co., New York	Williams & Clark's Acorn Acid Phosphate	Altamont	2284
The American Agricultural Chem. Co., New York	Williams & Clark's Americus Fertilizer	White Plains	3106
The American Agricultural Chem. Co., New York	Williams & Clark's Americus High Grade Special Fertilizer	Kingston	2263
The American Agricultural Chem. Co., New York	Williams & Clark's Americus Universal Fertilizer	Watervliet	3129
The American Agricultural Chem. Co., New York	Williams & Clark's "B" Fertilizer	Interlaken	3043
The American Agricultural Chem. Co., New York	Williams & Clark's Dissolved Phosphate and Potash	Interlaken	3042
The American Agricultural Chem. Co., New York	Williams & Clark's Good Grower Potato Phosphate	Port Jervis	2713
The American Agricultural Chem. Co., New York	Williams & Clark's Potato, Hop and Tobacco Fertilizer	Oneida	3001
The American Agricultural Chem. Co., New York	Williams & Clark's Potato Phosphate	Kingston	2264
The American Agricultural Chem. Co., New York	Williams & Clark's Potato Phosphate	Watervliet	3128
The American Agricultural Chem. Co., New York	Williams & Clark's Prolific Fertilizer	Altamont	2285

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
1799	Guaranteed Found	2.06 2.16	8. 8.33	9. 9.16	3. 3.66
3183	Guaranteed Found	.82 .94	8. 8.30	9. 10.57	2. 2.22
2670	Guaranteed Found	3.29 3.55	8. 8.48	9. 9.21	7. 7.30
2547	Guaranteed Found	——— ———	11. 10.95	12. 11.32	2. 2.34
2284	Guaranteed Found	——— ———	14. 14.62	15. 15.03	——— ———
3106	Guaranteed Found	2.47 2.68	9. 9.98	10. 10.80	2. 2.30
2263	Guaranteed Found	3.29 3.20	8. 8.83	9. 10.27	7. 7.18
3129	Guaranteed Found	1.65 1.58	8. 9.61	9. 10.35	2. 2.34
3043	Guaranteed Found	.82 1.	8. 8.76	9. 9.52	4. 4.10
3042	Guaranteed Found	——— ———	10. 10.07	11. 11.33	2. 2.18
2713	Guaranteed Found	.82 1.15	8. 8.31	9. 8.87	4. 4.36
3001	Guaranteed Found	2.06 1.85	8. 8.23	9. 9.48	3. 3.38
2264	Guaranteed Found	2.47 2.27	6. 7.50	7. 8.81	6. 5.96
3128	Guaranteed Found	2.47 2.59	6. 7.04	7. 7.76	6. 7.20
2285	Guaranteed Found	.82 .95	7. 7.71	8. 8.90	1. 1.44

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The American Agricultural Chem. Co., New York	Williams & Clark's Royal Phosphate	Kingston	2266
The American Agricultural Chem. Co., New York	Zell's Dissolved Phosphate	Binghamton	2448
The American Agricultural Chem. Co., New York	Zell's Economizer Phosphate	Binghamton	2447
The American Agricultural Chem. Co., New York	Zell's Electric Phosphate	Esperance	2726
The American Agricultural Chem. Co., New York	Zell's Fruit Tree Invigorator	Preble	2549
The American Agricultural Chem. Co., New York	Zell's General Crop Fertilizer	Canandaigua	2789
The American Agricultural Chem. Co., New York	Zell's High Grade Bone and Potash	Moravia	2512
The American Agricultural Chem. Co., New York	Zell's High Grade Wheat and Corn Manure	Binghamton	2042
The American Agricultural Chem. Co., New York	Zell's Special Potato and Cabbage Manure	Canandaigua	2788
American Fertilizing Co., Baltimore, Md.	American Champion Grain Grower	Moravia	2509
American Fertilizing Co., Baltimore, Md.	American Eagle Crop Grower	Moravia	2511
American Fertilizing Co., Baltimore, Md.	American Excelsior Guano	Caledonia	2763
American Fertilizing Co., Baltimore, Md.	American Formula Wheat and Corn	Arcade	3157
American Fertilizing Co., Baltimore, Md.	American Prize Truck Guano	South Dayton	2954
American Fertilizing Co., Baltimore, Md.	American Pure Raw Bone	South Dayton	2956
American Fertilizing Co., Baltimore, Md.	American Standard Crop Compound	Caledonia	2764
American Fertilizing Co., Baltimore, Md.	Ammoniated Bone Compound	Dansville	2999

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2266	Guaranteed Found	1.03 1.08	8. 8.89	9. 10.12	2. 2.16
2448	Guaranteed Found	—— ——	14. 14.	15. 15.53	—— ——
2447	Guaranteed Found	.82 .85	8. 8.78	9. 10.67	2. 2.04
2726	Guaranteed Found	—— ——	10. 10.08	11. 11.05	2. 2.28
2549	Guaranteed Found	—— ——	10. 9.86	11. 10.49	8. 8.44
2789	Guaranteed Found	.82 .87	8. 8.24	9. 9.08	4. 4.20
2512	Guaranteed Found	—— ——	12. 12.43	13. 12.74	5. 4.92
2042	Guaranteed Found	1.65 1.68	10. 10.31	11. 12.60	4. 3.94
2788	Guaranteed Found	.82 .79	9. 10.12	10. 12.12	7. 6.72
2509	Guaranteed Found	.82 .94	8. 8.48	9. 11.38	4. 4.08
2511	Guaranteed Found	1.65 1.66	8. 8.15	9. 10.73	2. 2.04
2763	Guaranteed Found	1.65 1.65	8. 8.29	9. 10.38	5. 5.24
3157	Guaranteed Found	—— ——	10. 10.51	11. 11.47	5. 5.68
2954	Guaranteed Found	1.65 1.84	8. 8.06	9. 9.48	10. 9.96
2956	Guaranteed Found	3.70 4.12	—— ——	22.50 21.78	—— ——
2764	Guaranteed Found	—— ——	10. 10.17	11. 11.13	8. 8.76
2999	Guaranteed Found	.82 1.03	8. 9.30	9. 11.71	2. 2.52

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
American Fertilizing Co., Baltimore, Md.	Dissolved Bone and Potash	Hamlin	2980
American Fertilizing Co., Baltimore, Md.	Double Extra Bone and Potash	Moravia	2510
American Fertilizing Co., Baltimore, Md.	High Grade Acid Phosphate	Batavia	2472
American Fertilizing Co., Baltimore, Md.	10% Tankage	South Dayton	2955
Armour Fertilizer Works, Baltimore, Md.	Armour's All Soluble Fertilizer	Homer	2401
Armour Fertilizer Works, Baltimore, Md.	Armour's Ammoniated Bone with Potash	Eden Center	2618
Armour Fertilizer Works, Baltimore, Md.	Armour's Banner Brand Fertilizer	McDonough	2184
Armour Fertilizer Works, Baltimore, Md.	Armour's Bean and Farm Fertilizer	Warsaw	2993
Armour Fertilizer Works, Baltimore, Md.	Armour's Blood	Rochester	2780
Armour Fertilizer Works, Baltimore, Md.	Armour's Blood Fertilizer	Wayland	3031
Armour Fertilizer Works, Baltimore, Md.	Armour's Bone, Blood and Potash	Riverhead	2302
Armour Fertilizer Works, Baltimore, Md.	Armour's Bone Meal Fertilizer	Syracuse	2560
Armour Fertilizer Works, Baltimore, Md.	Armour's Cauliflower, Celery and Potato Mixture	Aquebogue	2349
Armour Fertilizer Works, Baltimore, Md.	Armour's Crop Grower Fertilizer	Boonville	2686
Armour Fertilizer Works, Baltimore, Md.	Armour's 5-35 Tankage	Mumford	2762
Armour Fertilizer Works, Baltimore, Md.	Armour's Fruit and Root Crop Special Fertilizer	McDonough	2185
Armour Fertilizer Works, Baltimore, Md.	Armour's Grain Grower Fertilizer	McDonough	2183

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
		Pounds in 100 Pounds of Fertilizer.			
2980	Guaranteed	——	10.	11.	2.
	Found	——	10.33	11.83	2.28
2510	Guaranteed	——	12.	13.	5.
	Found	——	12.18	13.64	5.38
2472	Guaranteed	——	14.	15.	——
	Found	——	14.60	17.02	——
2955	Guaranteed	9.23	——	——	——
	Found	7.19	——	9.37	——
2401	Guaranteed	2.88	8.	——	4.
	Found	3.15	7.96	9.05	4.06
2618	Guaranteed	2.47	6.	——	2.
	Found	2.41	6.24	7.01	2.42
2184	Guaranteed	——	10.	——	8.
	Found	——	10.52	10.87	8.02
2993	Guaranteed	——	8.	——	4.
	Found	——	8.59	8.78	3.94
2780	Guaranteed	9.90	——	——	——
	Found	9.32	——	——	——
3031	Guaranteed	13.	——	——	——
	Found	13.50	——	——	——
2302	Guaranteed	4.11	8.	——	7.
	Found	3.96	7.97	9.18	7.30
2560	Guaranteed	2.47	——	22.50	——
	Found	2.49	——	24.31	——
2349	Guaranteed	4.94	8.	——	5.
	Found	5.23	7.28	9.14	5.30
2686	Guaranteed	.82	8.	——	2.
	Found	.87	8.31	8.94	2.14
2762	Guaranteed	4.11	——	16.	——
	Found	4.08	——	14.97	——
2185	Guaranteed	1.65	8.	——	5.
	Found	1.81	7.94	8.83	5.30
2183	Guaranteed	1.65	8.	——	2.
	Found	1.73	8.04	9.33	2.52

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Armour Fertilizer Works, Baltimore, Md.	Armour's High Grade Potato Fertilizer	Homer	2402
Armour Fertilizer Works, Baltimore, Md.	Armour's High Grade Potato Fertilizer	Walden	2706
Armour Fertilizer Works, Baltimore, Md.	Armour's Manure Substitute Fertilizer	Middletown	2292
Armour Fertilizer Works, Baltimore, Md.	Armour's Manure Substitute Fertilizer	Sidney Center	3024
Armour Fertilizer Works, Baltimore, Md.	Armour's Phosphate and Potash No. 1	Le Roy	2112
Armour Fertilizer Works, Baltimore, Md.	Armour's Potato and Grain Special Fertilizer	Holley	2149
Armour Fertilizer Works, Baltimore, Md.	Armour's Potato Special Fertilizer	Holley	2459
Armour Fertilizer Works, Baltimore, Md.	Armour's Raw Bone Meal	Rochester	2646
Armour Fertilizer Works, Baltimore, Md.	Armour's 6 & 30 Tankage Fertilizer	Riverhead	2317
Armour Fertilizer Works, Baltimore, Md.	Armour's Special Potato Grower	Hempstead	1797
Armour Fertilizer Works, Baltimore, Md.	Armour's Star Phosphate	Wards Island	2202
Armour Fertilizer Works, Baltimore, Md.	Armour's Star Phosphate Fertilizer	Riverhead	2325
Armour Fertilizer Works, Baltimore, Md.	Armour's Trucker's Special Fertilizer	Middletown	2293
Armour Fertilizer Works, Baltimore, Md.	Armour's Wheat and Clover Fertilizer	Le Roy	2113
Armour Fertilizer Works, Baltimore, Md.	Armour's Wheat, Corn and Oat Special Fertilizer	Newburgh	2714
Armour Fertilizer Works, Baltimore, Md.	Armour's York State Special Fertilizer	Homer	2403

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2402	Guaranteed Found	1.65 1.74	8. 8.26	—— 9.19	10. 10.46
2706	Guaranteed Found	1.65 1.90	8. 8.	—— 9.36	10. 10.38
2292	Guaranteed Found	3.29 2.78	6. 6.61	—— 7.22	4. 4.48
3024	Guaranteed Found	3.29 3.28	6. 6.11	—— 6.99	4. 4.62
2112	Guaranteed Found	—— ——	10. 9.83	—— 10.78	2. 1.96
2149	Guaranteed Found	.82 .93	9. 7.88	—— 8.95	7. 7.72
2459	Guaranteed Found	2.06 2.43	6. 6.02	—— 6.69	6. 6.42
2646	Guaranteed Found	3.70 4.37	—— ——	22. 22.47	—— ——
2317	Guaranteed Found	4.94 5.05	—— ——	13.74 17.20	—— ——
1797	Guaranteed Found	3.29 3.54	8. 7.39	—— 8.81	7. 7.94
2202	Guaranteed Found	—— ——	14. 13.63	—— 15.91	—— ——
2325	Guaranteed Found	—— ——	14. 13.94	—— 15.53	—— ——
2293	Guaranteed Found	3.29 3.07	6. 5.85	—— 6.53	10. 11.44
2113	Guaranteed Found	—— ——	10. 10.13	—— 10.83	5. 4.94
2714	Guaranteed Found	.82 .90	7. 6.95	—— 8.48	1. 1.28
2403	Guaranteed Found	.82 .95	8. 8.28	—— 9.11	4. 4.64

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Armour Fertilizer Works, Baltimore, Md.	Blood	Central Islip	2220
Armour Fertilizer Works, Baltimore, Md.	Dried Blood	Wards Island	1800
Armour Fertilizer Works, Baltimore, Md.	Dried Blood	Kings Park	2225
Armour Fertilizer Works, Baltimore, Md.	Fanning & Young's Special Potato Manure	Aquebogue	2375
Armour Fertilizer Works, Baltimore, Md.	Genuine German Kainit	Granville	2883
Armour Fertilizer Works, Baltimore, Md.	Muriate of Potash	Wards Island	2203
Armour Fertilizer Works, Baltimore, Md.	Muriate of Potash	Central Islip	2221
Armour Fertilizer Works, Baltimore, Md.	Muriate of Potash	Kings Park	2223
Armour Fertilizer Works, Baltimore, Md.	Muriate of Potash	Riverhead	2326
Armour Fertilizer Works, Baltimore, Md.	Nitrate of Soda	Wards Island	2201
Armour Fertilizer Works, Baltimore, Md.	Nitrate of Soda	Central Islip	2222
Armour Fertilizer Works, Baltimore, Md.	Nitrate of Soda	Kings Park	2224
Armour Fertilizer Works, Baltimore, Md.	Special Mixture	Wayland	3032
Armour Fertilizer Works, Baltimore, Md.	Sulphate of Potash	Peconic	2390
Armour Fertilizer Works, Baltimore, Md.	Sulphate of Potash	Amenia	2894
Armour Fertilizer Works, Baltimore, Md.	Sulphate of potash	Hornell	3025
Atlantic Fertilizer Co., Baltimore, Md.	Atlantic's Arrow Brand Special	Durhamville	3003

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2220	Guaranteed Found	13. 14.19	—— ——	—— ——	—— ——
1800	Guaranteed Found	9.86 10.42	—— ——	—— ——	—— ——
2225	Guaranteed Found	9.84 10.18	—— ——	—— ——	—— ——
2375	Guaranteed Found	3.29 3.66	7. 7.02	—— 9.17	5. 4.92
2883	Guaranteed Found	—— ——	—— ——	—— ——	12. 13.38
2203	Guaranteed Found	—— ——	—— ——	—— ——	48. 53.12
2221	Guaranteed Found	—— ——	—— ——	—— ——	48. 49.92
2223	Guaranteed Found	—— ——	—— ——	—— ——	48. 53.32
2326	Guaranteed Found	—— ——	—— ——	—— ——	48. 45.32
2201	Guaranteed Found	14.81 15.71	—— ——	—— ——	—— ——
2222	Guaranteed Found	15. 15.64	—— ——	—— ——	—— ——
2224	Guaranteed Found	14.81 15.64	—— ——	—— ——	—— ——
3032	Guaranteed Found	—— 3.47	—— ——	—— 15.35	—— ——
2390	Guaranteed Found	—— ——	—— ——	—— ——	48. 49.04
2894	Guaranteed Found	—— ——	—— ——	—— ——	48. 49.60
3025	Guaranteed Found	—— ——	—— ——	—— ——	50. 50.
3003	Guaranteed Found	.82 .85	8. 8.01	9. 8.63	4. 4.24

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Atlantic Fertilizer Co., Baltimore, Md.	Atlantic's Big Four Blood, Bone, Fish and Potash	Durhamville	3004
Atlantic Fertilizer Co., Baltimore, Md.	Atlantic's Crop Producer	Elmira	3019
Atlantic Fertilizer Co., Baltimore, Md.	Atlantic's Farmer's Alkaline Mixture	Elmira	3017
Atlantic Fertilizer Co., Baltimore, Md.	Atlantic's G. G. G. Golden Grain Grower	Elmira	3018
Atlantic Fertilizer Co., Baltimore, Md.	Atlantic's XX Special Compound for Potatoes	Durhamville	3002
Baltimore Pulverizing Co., Baltimore, Md.	Special 7% Potato Guano	Elmira	3016
Baugh & Sons Co., Baltimore, Md.	Baugh's Commercial Super-Phosphate for General Use	Moravia	2518
Baugh & Sons Co., Baltimore, Md.	Baugh's Complete Animal Base Fertilizer	Moravia	2519
Baugh & Sons Co., Baltimore, Md.	Baugh's High Grade Acid Phosphate	Potsdam	2672
Baugh & Sons Co., Baltimore, Md.	Baugh's Phosphate and Potash	Moravia	2517
Baugh & Sons Co., Baltimore, Md.	Baugh's Raw Bone Meal	Arkport	3029
Baugh & Sons Co., Baltimore, Md.	Muriate of Potash	Potsdam	2673
Baugh & Sons Co., Baltimore, Md.	Tankage	Arkport	3030
Baugh & Sons Co., Baltimore, Md.	12 & 5 Phosphate and Potash	Moravia	2520
The Berg Co., Philadelphia, Pa.	Berg's High Grade Potato Manure	Ossining	3115
The Berg Co., Philadelphia, Pa.	Berg's High Grade Truck Guano	Ossining	3116

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
3004	Guaranteed	2.47	6.	7.	6.
	Found	1.96	6.80	7.32	6.64
3019	Guaranteed	.41	8.	9.	2.
	Found	.87	8.44	9.09	2.34
3017	Guaranteed	—	10.	11.	2.
	Found	—	10.11	10.16	1.94
3018	Guaranteed	1.65	9.	10.	4.
	Found	1.56	9.08	9.33	4.12
3002	Guaranteed	1.65	8.	9.	10.
	Found	1.56	8.66	9.35	9.94
3016	Guaranteed	5.75	6.	—	5.
	Found	4.79	7.17	7.57	4.40
2518	Guaranteed	1.65	8.	—	10.
	Found	2.28	8.02	8.96	10.24
2519	Guaranteed	1.65	8.	—	5.
	Found	1.81	8.25	9.51	5.58
2672	Guaranteed	—	14.	—	—
	Found	—	15.50	16.10	—
2517	Guaranteed	—	10.	—	8.
	Found	—	10.65	11.92	8.10
3029	Guaranteed	3.70	—	21.50	—
	Found	3.54	—	21.70	—
2673	Guaranteed	—	—	—	48.
	Found	—	—	—	51.16
3030	Guaranteed	9.	—	—	—
	Found	9.32	—	—	—
2520	Guaranteed	—	12.	—	5.
	Found	—	12.30	13.34	5.24
3115	Guaranteed	3.	8.	—	10.
	Found	2.54	9.38	11.95	4.97
3116	Guaranteed	5.	7.	—	6.
	Found	4.42	7.56	9.63	5.44

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
The Berg Co., Philadelphia, Pa.	Berg's Raw Bone Fine	Ossining	3118
The Berg Co., Philadelphia, Pa.	Berg's S. B. M. Standard Bone Manure	Ossining	3117
Berkshire Fertilizer Co., Bridgeport, Conn.	Berkshire Ammoniated Bone Phosphate	East Schodack	2722
Berkshire Fertilizer Co., Bridgeport, Conn.	Berkshire Complete Fertilizer	Jamesport	2356
Berkshire Fertilizer Co., Bridgeport, Conn.	Berkshire Long Island Special	Orient	2656
Bonora Chemical Co., New York, N. Y.	Bonora	New York	3062
Bowker Fertilizer Co., New York, N. Y.	Bowker's Ammoniated Dissolved Bone	North Collins	2632
Bowker Fertilizer Co., New York, N. Y.	Bowker's Ammoniated Food for Flowers	Syracuse	2522
Bowker Fertilizer Co., New York, N. Y.	Bowker's Best Grain Fertilizer	Schuylerville	2869
Bowker Fertilizer Co., New York, N. Y.	Bowker's Blood, Bone and Potash	Riverhead	2347
Bowker Fertilizer Co., New York, N. Y.	Bowker's Corn and Grain Fertilizer	Mattituck	2355
Bowker Fertilizer Co., New York, N. Y.	Bowker's Corn and Grain Grower	Windsor	2172
Bowker Fertilizer Co., New York, N. Y.	Bowker's Corn and Wheat Guano	Gasport	2496
Bowker Fertilizer Co., New York, N. Y.	Bowker's Dissolved Phosphate	Windsor	2181
Bowker Fertilizer Co., New York, N. Y.	Bowker's Dissolved Phosphate	Windsor	3047
Bowker Fertilizer Co., New York, N. Y.	Bowker's Early Potato Manure	Hicksville	1783
Bowker Fertilizer Co., New York, N. Y.	Bowker's Empire State Phosphate and Potash	Windsor	2182

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric Acid.		
		Nitrogen.	Available.	Total.	Potash.
3118	Guaranteed Found	3. 3.78	—— ——	20. 22.48	—— ——
3117	Guaranteed Found	3. 2.52	8. 8.88	—— 11.02	6. 5.96
2722	Guaranteed Found	.8 1.45	8. 8.34	9. 8.84	2. 2.88
2356	Guaranteed Found	2.5 2.70	8. 7.43	9. 8.75	6. 6.62
2656	Guaranteed Found	3.3 3.30	6. 6.41	8. 6.72	7. 8.68
3062	Guaranteed Found	15. 15.54	3. 5.52	—— 5.53	3. 3.80
2632	Guaranteed Found	1.65 1.61	8. 8.64	9. 10.85	2. 1.96
2522	Guaranteed Found	2.47 2.61	6. 7.19	—— 9.14	2. 3.22
2869	Guaranteed Found	1.23 1.29	10. 9.99	11. 11.44	6. 6.20
2347	Guaranteed Found	4.11 4.23	7. 7.07	8. 8.72	7. 7.14
2355	Guaranteed Found	2.47 2.74	8. 7.93	9. 9.42	4. 4.38
2172	Guaranteed Found	.82 .98	8. 7.60	9. 9.44	4. 4.26
2496	Guaranteed Found	1.65 1.80	8. 8.26	9. 10.35	4. 3.97
2181	Guaranteed Found	—— ——	11. 13.64	12. 15.11	—— ——
3047	Guaranteed Found	—— ——	11. 14.24	12. 15.09	—— ——
1783	Guaranteed Found	3.29 3.42	7. 7.07	8. 8.92	7. 7.32
2182	Guaranteed Found	—— ——	8. 7.95	9. 10.30	3. 8.62

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Bowker Fertilizer Co., New York, N. Y.	Bowker's Empire State Phosphate and Potash	Windsor	3046
Bowker Fertilizer Co., New York, N. Y.	Bowker's Farm and Garden Phosphate	Huntington	2207
Bowker Fertilizer Co., New York, N. Y.	Bowker's Fresh Ground Bone	Huntington	2206
Bowker Fertilizer Co., New York, N. Y.	Bowker's Golden Harvest Fertilizer	Groton	2505
Bowker Fertilizer Co., New York, N. Y.	Bowker's Hill and Drill Phosphate	Syracuse	2434
Bowker Fertilizer Co., New York, N. Y.	Bowker's Hop and Potato Phosphate with Extra Potash	Cherry Valley	2741
Bowker Fertilizer Co., New York, N. Y.	Bowker's Lawn and Garden Dressing	Binghamton	2539
Bowker Fertilizer Co., New York, N. Y.	Bowker's Market Garden Fertilizer	Hicksville	1781
Bowker Fertilizer Co., New York, N. Y.	Bowker's Potash Fertilizer	Delhi	2596
Bowker Fertilizer Co., New York, N. Y.	Bowker's Potash or Staple Phosphate	Ogdensburg	2908
Bowker Fertilizer Co., New York, N. Y.	Bowker's Potato and Vegetable Fertilizer	Schuylerville	2868
Bowker Fertilizer Co., New York, N. Y.	Bowker's Six Per Cent Potato Fertilizer	Windsor	2179
Bowker Fertilizer Co., New York, N. Y.	Bowker's Soluble Phosphate	Iroquois	2633
Bowker Fertilizer Co., New York, N. Y.	Bowker's Special Crop Grower	Batavia	2478
Bowker Fertilizer Co., New York, N. Y.	Bowker's Super Phosphate with Potash for Grass and Grain	Greenwich	2867
Bowker Fertilizer Co., New York, N. Y.	Bowker's Sure Crop Phosphate	Syracuse	2436

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric Acid. Available.	Phosphoric Acid. Total.	Potash.
3046	Guaranteed Found	—— ——	8. 8.03	9. 9.76	3. 9.82
2207	Guaranteed Found	1.65 1.64	8. 8.30	9. 9.22	2. 2.12
2206	Guaranteed Found	2.47 2.56	—— ——	22.88 24.03	—— ——
2505	Guaranteed Found	—— ——	12. 11.94	13. 13.01	5. 5.36
2434	Guaranteed Found	2.47 2.65	9. 7.97	10. 9.67	2. 2.68
2741	Guaranteed Found	.82 1.20	8. 8.16	9. 9.01	5. 5.40
2539	Guaranteed Found	3.29 3.24	4. 4.83	8. 8.89	5. 5.44
1781	Guaranteed Found	2.47 2.46	6. 5.83	7. 7.69	10. 10.46
2596	Guaranteed Found	.82 1.09	6. 6.21	7. 7.23	2. 2.12
2908	Guaranteed Found	.82 .85	8. 8.20	9. 9.24	3. 3.80
2868	Guaranteed Found	2.47 2.83	8. 8.52	9. 9.68	4. 4.50
2179	Guaranteed Found	.82 .95	6. 6.82	7. 7.65	6. 6.40
2633	Guaranteed Found	—— ——	14. 14.34	15. 17.03	—— ——
2478	Guaranteed Found	1.65 1.60	8. 8.89	9. 10.41	10. 11.04
2867	Guaranteed Found	—— ——	10. 10.64	11. 12.78	2. 4.20
2436	Guaranteed Found	.82 .88	9. 8.73	10. 9.89	2. 2.22

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Bowker Fertilizer Co., New York, N. Y.	Bowker's Ten and Eight	Windsor	2173
Bowker Fertilizer Co., New York, N. Y.	Bowker's Ten Per Cent Manure	Windsor	2180
Bowker Fertilizer Co., New York, N. Y.	Genuine German Kainit	North Collins	2643
Bowker Fertilizer Co., New York, N. Y.	Muriate of Potash	Schuylerville	2871
Bowker Fertilizer Co., New York, N. Y.	Nitrate of Soda	Mattituck	2353
Bowker Fertilizer Co., New York, N. Y.	Nitrate of Soda	Iroquois	2634
Bowker Fertilizer Co., New York, N. Y.	Stockbridge Special Complete Manure for Corn and All Grain Crops	Batavia	2479
Bowker Fertilizer Co., New York, N. Y.	Stockbridge Special Complete Manure for Potatoes and Vegetables (1)	Windsor	2178
Bowker Fertilizer Co., New York, N. Y.	Stockbridge Special Complete Manure for Seeding Down, Permanent Dressing and Legumes 4	Centervillage	2588
Bowker Fertilizer Co., New York, N. Y.	Stockbridge Special Complete Manure for Top Dressing and for Forcing (3)	Syracuse	2435
Bradley and Green Fertilizer Co., Philadelphia, Pa.	Market Garden	Mineola	2233
The Buffalo Fertilizer Co., Buffalo, N. Y.	Animal Tankage	Buffalo	3179
The Buffalo Fertilizer Co., Buffalo, N. Y.	Bone Meal	Hamburg	2622
The Buffalo Fertilizer Co., Buffalo, N. Y.	Buffalo 5-8-7	Riverhead	2378
The Buffalo Fertilizer Co., Buffalo, N. Y.	Buffalo 5-7-10	South Lima	3170

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
2173	Guaranteed Found	—— ——	10. 9.74	11. 11.38	8. 8.68
2180	Guaranteed Found	.82 1.08	5. 5.18	6. 6.15	10. 9.96
2643	Guaranteed Found	—— ——	—— ——	—— ——	12. 11.87
2871	Guaranteed Found	—— ——	—— ——	—— ——	49. 50.42
2353	Guaranteed Found	15. 15.34	—— ——	—— ——	—— ——
2634	Guaranteed Found	15. 15.10	—— ——	—— ——	—— ——
2479	Guaranteed Found	3.29 3.44	10. 9.88	11. 11.44	7. 7.06
2178	Guaranteed Found	3.29 3.26	6. 6.15	7. 8.08	10. 9.72
2588	Guaranteed Found	2.47 2.61	6. 6.13	9. 7.26	10. 10.68
2435	Guaranteed Found	4.94 4.13	4. 4.57	6. 6.17	6. 6.46
2233	Guaranteed Found	3.25 3.28	8. 8.06	—— 8.93	6. 5.76
3179	Guaranteed Found	6.1 6.58	—— ——	—— ——	—— ——
2622	Guaranteed Found	2.9 2.77	—— ——	22. 21.30	—— ——
2378	Guaranteed Found	4.10 4.04	8. 7.80	9. 9.08	7. 7.40
3170	Guaranteed Found	4.11 3.80	7. 8.09	8. 8.71	10. 10.34

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Buffalo Fertilizer Co., Buffalo, N. Y.	Celery and Potato Special	Fancher	2146
The Buffalo Fertilizer Co., Buffalo, N. Y.	Celery and Potato Special	Boonville	2699
The Buffalo Fertilizer Co., Buffalo, N. Y.	Dissolved Phosphate	South Byron	2751
The Buffalo Fertilizer Co., Buffalo, N. Y.	Dissolved Phosphate	Collins	2800
The Buffalo Fertilizer Co., Buffalo, N. Y.	Dried Blood	South Byron	2752
The Buffalo Fertilizer Co., Buffalo, N. Y.	Dried Blood	Collins	2799
The Buffalo Fertilizer Co., Buffalo, N. Y.	Extra Phosphate and Potash	Newfane	2601
The Buffalo Fertilizer Co., Buffalo, N. Y.	Extra Phosphate and Potash	Silver Creek	2649
The Buffalo Fertilizer Co., Buffalo, N. Y.	Farmers Choice	Owego	2449
The Buffalo Fertilizer Co., Buffalo, N. Y.	Fish Guano	Fancher	2141
The Buffalo Fertilizer Co., Buffalo, N. Y.	Fish Tankage	Fairport	2975
The Buffalo Fertilizer Co., Buffalo, N. Y.	Floats	Brocton	2963
The Buffalo Fertilizer Co., Buffalo, N. Y.	Garbage Tankage	Oakfield	2770
The Buffalo Fertilizer Co., Buffalo, N. Y.	Garden Truck	Batavia	2607
The Buffalo Fertilizer Co., Buffalo, N. Y.	Garden Truck	Silver Creek	2648
The Buffalo Fertilizer Co., Buffalo, N. Y.	General Crop	Norwich	2529
The Buffalo Fertilizer Co., Buffalo, N. Y.	General Favorite	Savannah	2971

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric acid.		
		Nitrogen.	Available.	Total.	Potash.
2146	Guaranteed Found	1.6 1.82	8. 8.67	9. 9.31	10. 10.08
2699	Guaranteed Found	1.6 1.85	8. 8.99	9. 9.54	10. 9.74
2751	Guaranteed Found	—— ——	14. 13.56	15. 14.63	—— ——
2800	Guaranteed Found	—— ——	14. 13.20	15. 14.67	—— ——
2752	Guaranteed Found	9.84 10.40	—— ——	—— ——	—— ——
2799	Guaranteed Found	9.84 10.50	—— ——	—— ——	—— ——
2601	Guaranteed Found	—— ——	10. 9.87	11. 11.13	8. 8.18
2649	Guaranteed Found	—— ——	10. 10.13	11. 11.15	8. 7.74
2449	Guaranteed Found	.8 1.30	8. 8.46	9. 10.39	5. 6.
2141	Guaranteed Found	.8 .90	9. 8.58	10. 10.64	2. 2.34
2975	Guaranteed Found	6.5 7.59	—— ——	8 2.47	—— ——
2963	Guaranteed Found	—— ——	—— ——	25. 28.21	—— ——
2770	Guaranteed Found	2.25 2.61	—— ——	4. 3.94	.75 .72
2607	Guaranteed Found	3.3 3.36	8. 7.52	9. 9.23	7. 8.02
2648	Guaranteed Found	3.3 3.59	8. 7.47	9. 9.05	7. 7.56
2529	Guaranteed Found	—— ——	9. 9.09	10. 10.50	3. 2.92
2971	Guaranteed Found	1.2 1.66	8. 8.47	9. 10.65	2.5 2.74

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
The Buffalo Fertilizer Co., Buffalo, N. Y.	High Grade Manure	Lockport	2487
The Buffalo Fertilizer Co., Buffalo, N. Y.	Ideal Wheat and Corn	Fancher	2144
The Buffalo Fertilizer Co., Buffalo, N. Y.	Ideal Wheat and Corn	Boonville	2700
The Buffalo Fertilizer Co., Buffalo, N. Y.	Kainit	Brocton	2964
The Buffalo Fertilizer Co., Buffalo, N. Y.	Muriate of Potash	Iroquois	2636
The Buffalo Fertilizer Co., Buffalo, N. Y.	Muriate of Potash	Rochester	2781
The Buffalo Fertilizer Co., Buffalo, N. Y.	Muriate of Potash	Collins	2798
The Buffalo Fertilizer Co., Buffalo, N. Y.	Muriate of Potash	Ogdensburg	2906
The Buffalo Fertilizer Co., Buffalo, N. Y.	Nitrate of Soda	Riverhead	2379
The Buffalo Fertilizer Co., Buffalo, N. Y.	Phosphate and Potash	Moravia	2521
The Buffalo Fertilizer Co., Buffalo, N. Y.	Pure Raw Bone	Elmira	3023
The Buffalo Fertilizer Co., Buffalo, N. Y.	Sulphate of Potash	Buffalo	3180
The Buffalo Fertilizer Co., Buffalo, N. Y.	Tankage	Brocton	2962
The Buffalo Fertilizer Co., Buffalo, N. Y.	Vegetable and Potato	Owego	2450
Butts, J. P., Oneonta, N. Y.	High Grade Hop Fertilizer	Oneonta	2805
Butts, J. P., Oneonta, N. Y.	Hustler	Oneonta	2806
Butts, J. P., Oneonta, N. Y.	Potato Manure No. 1	Oneonta	2804

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric acid.		
		Nitrogen.	Available.	Total.	Potash.
2487	Guaranteed Found	3.3 4.30	7. 7.37	8. 8.99	10. 12.44
2144	Guaranteed Found	1.6 2.04	9. 10.29	10. 11.36	5. 6.10
2700	Guaranteed Found	1.6 1.65	9. 10.04	10. 10.58	5. 5.58
2964	Guaranteed Found	——— ———	——— ———	——— ———	12. 16.24
2636	Guaranteed Found	——— ———	——— ———	——— ———	48. 49.82
2781	Guaranteed Found	——— ———	——— ———	——— ———	48. 50.68
2798	Guaranteed Found	——— ———	——— ———	——— ———	48. 52.32
2906	Guaranteed Found	——— ———	——— ———	——— ———	48. 50.66
2379	Guaranteed Found	15. 15.35	——— ———	——— ———	——— ———
2521	Guaranteed Found	——— ———	12. 11.77	13. 13.02	5. 5.08
3023	Guaranteed Found	3.3 2.85	——— ———	23. 23.98	——— ———
3180	Guaranteed Found	——— ———	——— ———	——— ———	48. 50.76
2962	Guaranteed Found	6.15 6.26	——— ———	——— 12.22	——— ———
2450	Guaranteed Found	2.4 2.40	8. 8.	9. 8.97	7. 7.62
2805	Guaranteed Found	3.29 3.24	7. 7.22	8. 8.83	10. 10.76
2806	Guaranteed Found	.82 .98	8. 8.37	9. 9.78	4. 4.22
2804	Guaranteed Found	2.47 2.59	8. 8.14	9. 9.45	7. 7.42

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Butts, J. P., Oneonta, N. Y.	Standard No. 1	Oneonta	2839
Carpenter Sanitary Rendering Works, Elmira, N. Y.	Tankage	Elmira	3020
Case & Co., A. H., East Buffalo, N. Y.	Case's Complete Fertilizer No. 1 with Manure Filler	Basom	2768
Case & Co., A. H., East Buffalo, N. Y.	Excelsior Brand Pulverized Pig Manure	Basom	2766
Case & Co., A. H., East Buffalo, N. Y.	Excelsior Brand Pulverized Sheep Manure	Basom	2767
The E. D. Chittenden Co., Bridgeport, Conn.	Chittenden's Potato and Cauliflower	Mattituck	2318
The E. D. Chittenden Co., Bridgeport, Conn.	Chittenden's Potato and Cauliflower	Whitestone	3070
The E. D. Chittenden Co., Bridgeport, Conn.	Chittenden's Potato and Grain	Floral Park	1798
The E. D. Chittenden Co., Bridgeport, Conn.	Chittenden's Potato Special	East Williston	1774
The E. D. Chittenden Co., Bridgeport, Conn.	Nitrate of Soda	East Williston	1775
Clark & Son, O. W., Buffalo, N. Y.	Clark's Velvet Lawn Fertilizer	Buffalo	2757
Clark & Son, O. W., Buffalo, N. Y.	Plant Food	Buffalo	2756
The Clark-Baylis Co., Milford, Conn.	Corn & Cabbage Special Manure	Floral Park	2235
The Clark-Baylis Co., Milford, Conn.	Special High Grade with 10% Potash	Floral Park	2234
Clay & Son, Stratford, London, Eng.	Clay's Fertilizer	Rochester	2647
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Celebrated Special Potato Fertilizer	Wright	2606

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2839	Guaranteed Found	1.23 1.35	8. 8.40	9. 10.01	2.50 3.20
3020	Guaranteed Found	6.57 6.23	——— ———	6.93 9.61	——— ———
2768	Guaranteed Found	1.64 1.78	8. 8.27	——— 9.34	4. 4.18
2766	Guaranteed Found	1. 1.63	1. 1.75	——— 1.89	1. 7.12
2767	Guaranteed Found	1. 1.78	.87 .91	——— 1.04	1. 7.18
2318	Guaranteed Found	3.3 3.09	8. 8.74	10. 8.95	5. 4.90
3070	Guaranteed Found	3.3 3.57	8. 8.75	10. 8.93	5. 5.40
1798	Guaranteed Found	3.30 3.13	8. 7.23	10. 8.26	6. 6.46
1774	Guaranteed Found	3.30 3.39	8. 8.14	10. 9.34	7. 6.86
1775	Guaranteed Found	——— 14.87	——— ———	——— ———	——— ———
2757	Guaranteed Found	2. 3.08	5. 7.96	——— 9.10	3. 4.20
2756	Guaranteed Found	3.50 3.92	7. 7.55	——— 9.57	6. 6.98
2235	Guaranteed Found	4.93 4.74	6. 6.34	——— 8.18	6. 6.82
2234	Guaranteed Found	3.29 3.50	6. 6.35	——— 8.23	10. 10.28
2647	Guaranteed Found	4. 4.48	1.15 2.77	7.20 8.88	.10 .24
2606	Guaranteed Found	1.65 1.77	8. 8.06	9. 9.73	4. 4.04

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Columbian Corn & Potato Fertilizer	Perry	3171
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Double Strength Potato Manure	Cortland	2156
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Economical Potato Manure	Cherry Valley	2749
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Empire State Brand	Savannah	2970
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Excelsior Potato Fertilizer	West Oneonta	2842
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Extra Special Potato Fertilizer and Fruit Grower	Cortland	2157
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Famous Prize Brand Grain and Grass Fertilizer	Hayts Corners	2581
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Golden Harvest Fertilizer	Cortland	2155
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Grain and Vegetable Grower	Ithaca	2567
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's High Grade Dissolved Phosphate and Potash	Perry	2102
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's High Grade Soluble Phosphate	West Coxsackie	2252
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's High Grade Soluble Phosphate	Bedford Hills	3103
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's New Englander Corn & Potato Fertilizer	Amsterdam	2854
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Onondaga Special Fertilizer for All Crops	Ithaca	2568

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
3171	Guaranteed Found	1.23 1.38	8.50 9.55	9.50 10.94	2.50 2.78
2156	Guaranteed Found	3.70 3.72	7. 7.56	8.50 8.54	10. 10.54
2749	Guaranteed Found	.80 .93	4. 4.28	5. 5.69	8. 8.30
2970	Guaranteed Found	1.23 1.33	9. 9.48	10. 11.14	6. 6.30
2842	Guaranteed Found	2.47 2.62	7. 7.86	8. 9.13	8. 8.24
2157	Guaranteed Found	1.65 1.70	8. 8.82	9. 10.12	10. 9.86
2581	Guaranteed Found	—— ——	10. 10.38	11. 11.24	2. 2.20
2155	Guaranteed Found	—— ——	10. 10.29	11. 10.98	8. 7.94
2567	Guaranteed Found	.80 .96	8. 8.11	9. 9.32	7. 7.46
2102	Guaranteed Found	—— ——	8. 8.29	9. 8.93	5. 5.44
2252	Guaranteed Found	—— ——	14. 14.60	15. 15.78	—— ——
3103	Guaranteed Found	—— ——	14. 14.24	15. 15.79	—— ——
2854	Guaranteed Found	.80 1.00	7.50 7.93	8.50 10.75	3. 3.34
2568	Guaranteed Found	.80 .88	7. 7.28	8. 8.75	1. 1.20

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Red Brand Excelsior Guano for Market Gardening	Cortland	2153
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Special 2-9-5 for Wheat, Corn and Cereals	Elba	2772
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's 12-5 Dissolved Phosphate and Potash	Hayts Corners	2579
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's 12 Per Cent Superphosphate	Cherry Valley	2748
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's Western New Yorker	Churchville	2484
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's XXV Ammoniated Bone Phosphate	Wright	2605
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's XXV Ammoniated Bone Phosphate	Arcade	3156
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's XXX Fine Ground Bone	Maryland	2836
The Coe-Mortimer Co., New York, N. Y.	E. Frank Coe's XXX Fine Ground Bone	Bedford Hills	3102
The Coe-Mortimer Co., New York, N. Y.	Bedford Farmers Corn and Grain Fertilizer	Bedford Hills	2897
The Coe-Mortimer Co., New York, N. Y.	Bedford Farmers Potato and Garden Fertilizer	Bedford Hills	2898
The Coe-Mortimer Co., New York, N. Y.	Bedford Farmers Potato and Garden Fertilizer	Bedford Hills	3068
The Coe-Mortimer Co., New York, N. Y.	Muriate of Potash	Bedford Hills	2900
The Coe-Mortimer Co., New York, N. Y.	Nitrate of Soda	West Coxsackie	2253
The Coe-Mortimer Co., New York, N. Y.	Nitrate of Soda	Bedford Hills	2899

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2153	Guaranteed Found	3.30 3.31	8. 8.28	9. 9.45	7. 7.48
2772	Guaranteed Found	1.65 1.74	9. 9.25	10. 10.95	5. 5.78
2579	Guaranteed Found	—— ——	12. 12.52	13. 12.95	5. 5.32
2748	Guaranteed Found	—— ——	12. 13.65	13. 15.74	—— ——
2484	Guaranteed Found	.80 1.07	8. 8.10	9. 9.34	4. 4.08
2605	Guaranteed Found	.80 .87	8.50 8.40	9.50 9.32	1.50 1.44
3156	Guaranteed Found	.80 .99	8.50 10.72	9.50 11.03	1.50 1.80
2836	Guaranteed Found	2.50 2.45	—— ——	23. 25.42	—— ——
3102	Guaranteed Found	2.50 2.63	—— ——	23. 24.44	—— ——
2897	Guaranteed Found	3. 3.40	8. 8.43	9. 10.38	6. 6.
2898	Guaranteed Found	4. 5.45	10. 8.72	11. 10.26	8. 7.80
3068	Guaranteed Found	4. 5.34	10. 9.51	11. 11.89	8. 7.36
2900	Guaranteed Found	—— ——	—— ——	—— ——	49. 50.44
2253	Guaranteed Found	15 15.28	—— ——	—— ——	—— ——
2899	Guaranteed Found	15. 15.44	—— ——	—— ——	—— ——

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Coe-Mortimer Co., New York, N. Y.	Thomas Phosphate Powder (Basic Slag Phosphate)	Wright	2603
The Coe-Mortimer Co., New York, N. Y.	Thomas Phosphate Powder	North Collins	2642
The Coe-Mortimer Co., New York, N. Y.	Thomas Phosphate Powder (Basic Slag Phosphate)	Bedford Hills	3101
Columbia Guano Co., Baltimore, Md.	Columbia Double Ten Potash Mixture	Melrose	2888
Columbia Guano Co., Baltimore, Md.	Columbia Fish Phosphate and Potash	Berkshire	3009
The Coe-Mortimer Co., New York, N. Y.	Columbia 14% Acid Phosphate	Melrose	2890
The Coe-Mortimer Co., New York, N. Y.	Columbia Grain Special Fertilizer	Boonville	2692
The Coe-Mortimer Co., New York, N. Y.	Columbia High Grade Acid Phosphate	Broadalbin	3131
The Coe-Mortimer Co., New York, N. Y.	Columbia Manure Substitute	Melrose	2889
The Coe-Mortimer Co., New York, N. Y.	Columbia Premium Phosphate and Potash	Cortland	2168
The Coe-Mortimer Co., New York, N. Y.	Columbia Soluble Guano	Boonville	2694
The Coe-Mortimer Co., New York, N. Y.	Columbia Special Potato Formula	Cortland	2167
The Coe-Mortimer Co., New York, N. Y.	Columbia Special Potato Guano	Boonville	2691
The Coe-Mortimer Co., New York, N. Y.	Columbia Wheat, Corn & Grass Special Fertilizer	Melrose	2891
The Coe-Mortimer Co., New York, N. Y.	Genuine German Kainit	Canastota	3005
The Coe-Mortimer Co., New York, N. Y.	Nitrate of Soda	Cortland	2166

* No official method for the determining of available P_2O_5 in this sample.

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2603	Guaranteed Found	—— ——	15. *	17. 17.15	—— ——
2642	Guaranteed Found	—— ——	15. *	17. 18.56	—— ——
3101	Guaranteed Found	—— ——	15. *	17. 18.34	—— ——
2888	Guaranteed Found	—— ——	10. 9.69	10.50 10.22	10. 10.70
3009	Guaranteed Found	1.65 1.63	8. 8.57	8.50 9.53	3. 3.10
2890	Guaranteed Found	—— ——	14. 13.95	14.50 14.78	—— ——
2692	Guaranteed Found	.82 1.12	8. 8.22	8.50 9.02	2. 2.42
3131	Guaranteed Found	—— ——	16. 16.23	16.50 16.43	—— ——
2889	Guaranteed Found	1.02 1.23	8. 8.26	8.50 8.93	2. 2.76
2168	Guaranteed Found	—— ——	10. 9.77	10.50 10.29	8. 8.38
2694	Guaranteed Found	1.65 1.74	8. 8.16	8.50 9.13	2. 2.38
2167	Guaranteed Found	1.65 1.84	8. 7.56	8.50 8.64	10. 11.22
2691	Guaranteed Found	1.65 1.78	5. 5.47	5.50 5.98	10. 10.54
2891	Guaranteed Found	.82 .88	8. 7.98	8.50 8.43	1. 1.44
3005	Guaranteed Found	—— ——	—— ——	—— ——	12. 13.28
2166	Guaranteed Found	15. 15.14	—— ——	—— ——	—— ——

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Cooper's Fertilizer, Peter, New York, N. Y.	Five-Eight-Seven	Riverhead	2360
Cooper's Fertilizer, Peter, New York, N. Y.	Five-Ten-Five	Cutchogue	2393
Cooper's Fertilizer, Peter, New York, N. Y.	Four-Eight-Seven	Riverhead	2361
Cooper's Fertilizer, Peter, New York, N. Y.	Four-Eight-Seven	Northport	3067
Cooper's Fertilizer, Peter, New York, N. Y.	Kainit	Riverhead	2359
Cooper's Fertilizer, Peter, New York, N. Y.	Peter Cooper's Corn and Wheat Special	New Rochelle	3109
Cooper's Fertilizer, Peter, New York, N. Y.	Peter Cooper's Ground Bone	Southold	2664
Cooper's Fertilizer, Peter, New York, N. Y.	Peter Cooper's Pure Bone Dust	Jamaica	2212
Cooper's Fertilizer, Peter, New York, N. Y.	Six-Eight-Five	Cutchogue	2392
Daniels, Fred, Johnsonburg, N. Y.	Daniels Commonsense Grain and Grass Grower	Johnsonburg	3158
Davidge, William M., Brooklyn, N. Y.	Davidge's Concentrated Manure	Mineola	2231
Davidge, William M., Brooklyn, N. Y.	Davidge's Special Phosphorus	Rye	3108
Fanning, Wm. R., Riverhead, N. Y.	Mixed Fertilizer	Riverhead	2335
The Fertilizer Material Supply Co., New York, N. Y.	Acid Phosphate	Central Islip	2219
The Fertilizer Material Supply Co., New York, N. Y.	Acid Phosphate	Kings Park	2226
The Fertilizer Material Supply Co., New York, N. Y.	Acid Phosphate	Riverhead	2332
The Fertilizer Material Supply Co., New York, N. Y.	Acid Phosphate	Rochester	2779

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2360	Guaranteed	4.11	8.	9.	7.
	Found	3.55	6.29	9.04	7.16
2393	Guaranteed	4.11	10.	11.	5.
	Found	4.11	9.84	11.13	5.04
2361	Guaranteed	3.25	8.	9.	7.
	Found	2.93	6.97	9.59	6.98
3067	Guaranteed	3.25	8.	9.	7.
	Found	4.43	11.	12.94	6.22
2359	Guaranteed	——	——	——	——
	Found	——	——	——	13.56
3109	Guaranteed	1.65	8.	9.	2.
	Found	1.50	7.89	9.72	1.96
2664	Guaranteed	1.26	——	20.61	——
	Found	1.47	——	22.83	——
2212	Guaranteed	2.05	——	22.90	——
	Found	2.75	——	23.68	——
2392	Guaranteed	4.94	8.	9.	5.
	Found	4.86	7.56	9.48	4.94
3158	Guaranteed	——	14.	15.	——
	Found	——	16.77	16.93	——
2231	Guaranteed	.20	——	——	——
	Found	2.44	——	1.99	.68
3108	Guaranteed	——	——	5.	——
	Found	.59	——	13.83	——
2335	Guaranteed	——	——	——	——
	Found	4.38	7.98	9.25	8.12
2219	Guaranteed	——	14.	——	——
	Found	——	14.74	15.34	——
2226	Guaranteed	——	14.	——	——
	Found	——	15.44	16.18	——
2332	Guaranteed	——	14.	——	——
	Found	——	16.25	16.96	——
2779	Guaranteed	——	14.	——	——
	Found	——	14.12	15.58	——

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Fertilizer Material Supply Co., New York, N. Y.	Acid Phosphate	Ogdensburg	2904
The Fertilizer Material Supply Co., New York, N. Y.	Animal Tankage	Riverhead	2340
The Fertilizer Material Supply Co., New York, N. Y.	Fish Scrap	Riverhead	2334
The Fertilizer Material Supply Co., New York, N. Y.	Muriate of Potash	Riverhead	2331
The Fertilizer Material Supply Co., New York, N. Y.	Nitrate of Soda	Riverhead	2330
The Fertilizer Material Supply Co., New York, N. Y.	Nitrate of Soda	Riverhead	2337
The Fertilizer Material Supply Co., New York, N. Y.	Nitrate of Soda	Collins	2951
The Fertilizer Material Supply Co., New York, N. Y.	No. 1 Potato and General Truck Fertilizer	Jamaica	2216
The Fertilizer Material Supply Co., New York, N. Y.	Tankage	Riverhead	2333
Flower City Plant Food Co., Rochester, N. Y.	Walker's Excelsior Plant Food	Rochester	2761
Francis, Camerden Co., Quogue, N. Y.	Humus Leaf Mold	Quogue	3066
Giddings, Burt L., Baldwinsville, N. Y.	Burts' Banner	Baldwinsville	2557
Griffith & Boyd Co., Baltimore, Md.	Dried Blood	Victor	2785
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s Farmers Potato Manure	Venice Center	2816
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s Fish Bone and Potash	Victor	2783
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s Gilt Edge Crop Guano	Stanley	2796

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2904	Guaranteed Found	—— ——	14. 14.51	—— 14.67	—— ——
2340	Guaranteed Found	6.58 6.92	—— ——	11.44 9.38	—— ——
2334	Guaranteed Found	8.57 8.36	4.45 ——	5.99 5.74	—— ——
2331	Guaranteed Found	—— ——	—— ——	—— ——	50. 51.18
2330	Guaranteed Found	15. 15.65	—— ——	—— ——	—— ——
2337	Guaranteed Found	15. 15.36	—— ——	—— ——	—— ——
2951	Guaranteed Found	15. 15.65	—— ——	—— ——	—— ——
2216	Guaranteed Found	3.31 4.44	8. 8.64	—— 10.42	7. 8.16
2333	Guaranteed Found	6.58 7.39	—— ——	11.44 10.35	—— ——
2761	Guaranteed Found	10. 8.47	12. 10.17	—— 10.19	11. 13.01
3066	Guaranteed Found	.82 1.08	—— ——	.10 .06	.05 .00
2557	Guaranteed Found	.80 1.29	8. 9.15	—— 10.89	4. 4.88
2785	Guaranteed Found	—— 11.76	—— ——	—— ——	—— ——
2816	Guaranteed Found	.85 .98	8. 7.76	9. 9.94	9. 8.58
2783	Guaranteed Found	1.50 1.26	7. 7.58	8. 9.09	3. 3.04
2796	Guaranteed Found	1.65 1.71	8. 7.77	9. 9.85	10. 8.47

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s High Grade Acid Phosphate	Victor	2787
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s Royal Potash Guano	Locke	2850
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s Special Grain Grower	Locke	2849
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s Special Guano	Victor	2782
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s 10 and 8	Victor	2784
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s Vegetable and Tobacco Grower	Stanley	2793
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s Vegetable Bone	Moravia	2814
Griffith & Boyd Co., Baltimore, Md.	Griffith & Boyd Co.'s XX Potash Manure	Moravia	2815
Griffith & Boyd Co., Baltimore, Md.	Muriate of Potash	Victor	2786
Guile, Charles, Fulton, N. Y.	Wool Waste Fertilizer	Albion	2463
Hammond's Slug Shot Works, Fishkill Landing, N. Y.	Hammond's Sward Food	Fishkill Landing	3119
Health Chemical Co., Yonkers, N. Y.	Bone Meal	Yonkers	3112
Health Chemical Co., Yonkers, N. Y.	Victor Brand	Yonkers	3113
Health Chemical Co., Yonkers, N. Y.	Westchester Brand	Yonkers	3111
Henderson & Co., Peter, New York, N. Y.	Henderson's Blood and Bone Fertilizer	New York	3055
Henderson & Co., Peter, New York, N. Y.	Henderson's Cabbage and Cauliflower Fertilizer	New York	3053
Henderson & Co., Peter, New York, N. Y.	Henderson's Corn Fertilizer	New York	3056

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric Acid.		
		Nitrogen.	Available.	Total.	Potash.
2787	Guaranteed	——	14.	16.	——
	Found	——	14.55	16.08	——
2850	Guaranteed	.85	8.	9.	4.
	Found	1.07	8.23	10.33	4.28
2849	Guaranteed	——	10.	11.	2.
	Found	——	9.54	11.72	2.22
2782	Guaranteed	1.65	8.	9.	5.
	Found	1.70	7.86	8.84	5.32
2784	Guaranteed	——	10.	11.	8.
	Found	——	10.07	12.	7.12
2793	Guaranteed	1.65	6.	7.	10.
	Found	2.14	6.64	8.80	10.98
2814	Guaranteed	2.47	8.	9.	7.
	Found	2.93	7.31	9.05	6.64
2815	Guaranteed	——	10.	11.	5.
	Found	——	10.68	12.77	4.17
2786	Guaranteed	——	——	——	50.
	Found	——	——	——	49.08
2463	Guaranteed	.75	.75	——	2.
	Found	1.20	.22	.31	3.12
3119	Guaranteed	2.35	4.50	5.50	4.60
	Found	2.38	5.	5.75	4.21
3112	Guaranteed	.90	10.	——	——
	Found	1.12	15.46	23.53	——
3113	Guaranteed	——	4.	5.	4.
	Found	——	9.72	16.58	9.72
3111	Guaranteed	.80	6.	7.	6.
	Found	1.72	6.73	11.18	4.98
3055	Guaranteed	2.47	8.	9.	2.50
	Found	2.59	8.71	9.83	2.78
3053	Guaranteed	4.11	7.	8.	7.
	Found	5.27	8.86	9.34	6.21
3056	Guaranteed	2.47	10.	11.	5.
	Found	2.68	10.06	11.04	5.88

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Henderson & Co., Peter, New York, N. Y.	Henderson's Garden Fertilizer	New York	3058
Henderson & Co., Peter, New York, N. Y.	Henderson's Plant Food Tablets	New York	3060
Henderson & Co., Peter, New York, N. Y.	Henderson's Potato Fertilizer	New York	3057
Henderson & Co., Peter, New York, N. Y.	Henderson's Pure Bone	New York	3054
Henderson & Co., Peter, New York, N. Y.	Henderson's Universal Superphosphate	New York	3052
Henderson & Co., Peter, New York, N. Y.	The Henderson Lawn Enricher	New York	3059
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Ammoniated Superphosphate	Glen Cove	1778
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Bean Fertilizer	East Marion	2396
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Farmers' Grain and Clover Grower	Jamestown	2959
Hess & Bro., Inc., S. M., Philadelphia, Pa.	High Grade Ground Bone	Southold	2663
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Nitrate of Soda	Riverhead	2343
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Potato and Truck Manure	Glen Cove	1777
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Special Cabbage Manure	Glen Head	1780
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Special Compound	Glen Cove	1776
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Special Corn Manure	Jamestown	2960
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Special Fish and Potash Manure	Glen Head	1779
Hess & Bro., Inc., S. M., Philadelphia, Pa.	Special Potato Manure	East Williston	1773

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
3058	Guaranteed Found	4.12 4.17	7. 7.75	—— 8.20	5. 5.68
3060	Guaranteed Found	7. 9.06	7. 10.71	—— 10.74	7. 9.46
3057	Guaranteed Found	3.70 4.08	7. 7.78	8. 8.50	8. 8.36
3054	Guaranteed Found	2.47 3.74	—— ——	20. 26.25	—— ——
3052	Guaranteed Found	2.47 2.80	8. 9.04	9. 10.11	4. 4.20
3059	Guaranteed Found	2.47 2.42	3.50 4.95	—— 5.70	2.50 2.98
1778	Guaranteed Found	1.65 2.02	8. 8.51	9. 9.66	2. 2.96
2396	Guaranteed Found	—— ——	10. 10.86	11. 11.20	8. 7.50
2959	Guaranteed Found	—— ——	10. 9.90	11. 11.61	8. 7.68
2663	Guaranteed Found	3.29 3.25	—— ——	20.59 22.75	—— ——
2343	Guaranteed Found	15. 15.51	—— ——	—— ——	—— ——
1777	Guaranteed Found	2.47 2.50	8. 8.40	9. 9.39	6. 6.60
1780	Guaranteed Found	3.29 3.24	6. 6.97	7. 7.93	4. 4.34
1776	Guaranteed Found	.82 1.61	8. 8.14	9. 9.25	4. 4.56
2960	Guaranteed Found	.82 1.11	8. 8.21	9. 10.15	2. 2.30
1779	Guaranteed Found	2.06 2.18	8. 8.33	9. 9.25	3. 3.66
1773	Guaranteed Found	3.29 3.53	8. 8.38	9. 9.22	7. 7.10

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Hubbard Fertilizer Co., Baltimore, Md.	Hubbard's Famous IXL	Windsor	2584
The Hubbard Fertilizer Co., Baltimore Md.	Hubbard's 14% Phosphate	Schenevus	2835
The Hubbard Fertilizer Co., Baltimore, Md.	Hubbard's Jewel Phosphate	Schenevus	2833
The Hubbard Fertilizer Co., Baltimore, Md.	Hubbard's Oriental Phosphate	Windsor	2585
The Hubbard Fertilizer Co., Baltimore, Md.	Hubbard's 16% Phosphate	Schenevus	2834
The Hubbard Fertilizer Co., Baltimore, Md.	Hubbard's Special Potato Fertilizer	Windsor	2586
The Hubbard Fertilizer Co., Baltimore, Md.	Hubbard's 12–5 Alkaline	Windsor	2583
International Seed Co., Rochester, N. Y.	International A 1 Special Manure	Chester	2704
International Seed Co., Rochester, N. Y.	International Electric Fertilizer	Le Roy	2106
International Seed Co., Rochester, N. Y.	International Grain and Grass Fertilizer	Le Roy	2104
International Seed Co., Rochester, N. Y.	International Potato and Truck Manure	Le Roy	2105
The Jarecki Chemical Co., Sandusky, O.	Black Diamond Fish Guano	Medina	2458
The Jarecki Chemical Co., Sandusky, O.	Fish and Potash Garden Fertilizer	Albion	2119
The Jarecki Chemical Co., Sandusky, O.	Fish and Potash General Grower	Attica	2469
The Jarecki Chemical Co., Sandusky, O.	Fish and Potash Truck Manure	Gasport	2497
The Jarecki Chemical Co., Sandusky, O.	Ground Bone	Hamburg	2617
The Jarecki Chemical Co., Sandusky, O.	Humus Phosphate with Potash	Attica	2470

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric acid.		
		Nitrogen.	Available.	Total.	Potash.
2584	Guaranteed Found	1.64 1.62	8. 8.78	9. 9.52	2. 2.06
2835	Guaranteed Found	—— ——	14. 16.46	16. 17.41	—— ——
2833	Guaranteed Found	1. 1.32	8. 8.41	10. 9.08	5. 5.96
2585	Guaranteed Found	.82 .94	8. 10.09	9. 11.79	2. 2.32
2834	Guaranteed Found	—— ——	16. 16.03	—— 16.57	—— ——
2586	Guaranteed Found	3.28 3.02	6. 6.61	7. 8.76	10. 10.46
2583	Guaranteed Found	—— ——	12. 12.11	—— 14.46	5. 4.56
2704	Guaranteed Found	2.40 2.56	6. 7.12	7. 9.28	10. 10.44
2106	Guaranteed Found	.82 1.06	8. 7.88	9. 10.34	2. 2.40
2104	Guaranteed Found	1.23 1.63	10. 10.14	11. 12.84	2.50 2.76
2105	Guaranteed Found	1.23 1.38	8. 8.13	9. 10.23	7. 6.94
2458	Guaranteed Found	1.66 1.73	8. 8.26	—— 8.98	4. 4.22
2119	Guaranteed Found	1.66 1.80	8. 7.83	—— 8.25	10. 10.34
2469	Guaranteed Found	.83 .94	7. 7.89	—— 8.31	3. 3.
2497	Guaranteed Found	3.33 3.23	8. 8.16	—— 8.55	7. 7.38
2617	Guaranteed Found	2.50 2.38	—— ——	20. 24.16	—— ——
2470	Guaranteed Found	.20 .38	10. 10.79	—— 11.34	8. 7.81

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Jarecki Chemical Co., Sandusky, O.	Special Cabbage and Onion Guano	Gasport	2493
The Jarecki Chemical Co., Sandusky, O.	Square Brand Phosphate and Potash	Attica	2471
Joynt, John, Lucknow, Ontario.	Canada Unleached Hardwood Ashes, The Joynt Brand	Owego	2501
Lalor, F. R., Dunnville, Ontario.	Maple Brand Unleached H. W. Ashes	Oneonta	2840
Lindner, P. W. F., Lynbrook, L. I.	Lindner's Complete Vegetable & Vine Fertilizer	Lynbrook	2239
Lindner, P. W. F., Lynbrook, L. I.	Lindner's High Grade Special Manure	Lynbrook	2238
Lindner, P. W. F., Lynbrook, L. I.	Lindner's Potato and Truck Fertilizer	Lynbrook	2236
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Ammoniated Dissolved Bone Phosphate	Greene	2538
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Atlas Brand Bone and Potash	Holcomb	3169
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Bone Meal	Skaneateles	2417
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Buyer's Choice Acid Phosphate	Skaneateles	2416
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Cauliflower and Cabbage Fertilizer	Otego	2843
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Cauliflower and Cabbage Fertilizer	Sanborn	2990
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Celebrated Ground Bone and Tankage Acidulated	Bloomville	2597
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Corn and Potato Fertilizer	Marathon	2049
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Corn No. 2 Fertilizer	Skaneateles	2413

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2493	Guaranteed Found	.83 .95	10. 10.10	——— 10.75	8. 8.56
2471	Guaranteed Found	——— ———	10. 9.97	——— 10.93	2. 1.52
2501	Guaranteed Found	——— ———	——— ———	1. 1.31	2. 3.42
2840	Guaranteed Found	——— ———	1. .48	——— 1.05	3. 2.74
2239	Guaranteed Found	2. 2.93	8. 8.13	——— 8.54	6. 6.14
2238	Guaranteed Found	4. 4.17	8. 8.58	——— 9.06	7. 7.40
2236	Guaranteed Found	3.25 2.98	8. 8.03	——— 9.01	7. 7.02
2538	Guaranteed Found	2.06 2.27	8. 8.53	9. 11.07	1.50 1.50
3169	Guaranteed Found	——— ———	12. 12.46	13. 12.97	5. 5.04
2417	Guaranteed Found	2.67 2.93	——— ———	22.88 25.95	——— ———
2416	Guaranteed Found	——— ———	14. 14.47	15. 15.37	——— ———
2843	Guaranteed Found	3.29 3.58	8. 8.17	9. 9.87	7. 7.42
2990	Guaranteed Found	3.29 3.43	8. 8.81	9. 10.	7. 6.84
2597	Guaranteed Found	2.67 2.84	6. 8.64	12. 12.60	——— ———
2049	Guaranteed Found	1.65 1.73	8. 7.68	9. 9.99	3. 3.48
2413	Guaranteed Found	1.65 1.80	10. 10.60	11. 12.16	4. 4.02

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Dissolved Phosphate and Potash	Cherry Valley	2747
Listers Agricultural Chemical Works, Newark, N. J.	Lister's G. Brand	Albion	2136
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Grain and Grass Fertilizer	Albion	2137
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Lawn Fertilizer	Schenectady	2858
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Long Island Special for Cabbage and Cauliflower	Mineola	2240
Listers Agricultural Chemical Works, Newark, N. J.	Lister's New York Special Fertilizer	Cortland	2544
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Oneida Special	Jamaica	1785
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Potato Manure	Marathon	2050
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Potato No. 2 Fertilizer	Skaneateles	2418
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Reliance	Brockport	2464
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Special Potato Fertilizer	Jamaica	1784
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Special 10% Potato Fertilizer	Skaneateles	2412
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Special Wheat Fertilizer	Syracuse	2559
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Standard Pure Bone Super-Phosphate of Lime	Binghamton	2446
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Success Fertilizer	Homer	2197
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Superior Dissolved Phosphate & Potash	Marathon	2048

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2747	Guaranteed Found	——— ———	10. 9.43	11. 9.72	2. 1.94
2136	Guaranteed Found	.82 .94	8. 7.92	9. 8.99	4. 4.08
2137	Guaranteed Found	——— ———	9. 8.89	10. 9.25	5. 5.14
2858	Guaranteed Found	1.65 2.01	8. 8.02	9. 10.06	3. 3.20
2240	Guaranteed Found	4.11 4.03	5. 5.18	6. 6.40	4. 4.76
2544	Guaranteed Found	.82 .95	8. 8.14	9. 8.91	10. 10.
1785	Guaranteed Found	.82 1.03	7. 7.46	8. 8.54	1. 2.36
2050	Guaranteed Found	3.29 3.29	8. 8.02	9. 9.84	7. 7.
2418	Guaranteed Found	1.65 1.88	10. 10.02	11. 12.14	4. 3.93
2464	Guaranteed Found	1.03 1.37	8. 8.21	9. 9.32	2. 2.16
1784	Guaranteed Found	1.65 1.83	8. 8.01	9. 10.24	3. 3.46
2412	Guaranteed Found	1.65 1.74	8. 8.01	9. 9.55	10. 10.14
2559	Guaranteed Found	1.65 1.72	8. 8.02	9. 9.92	3. 3.08
2446	Guaranteed Found	2.47 2.54	9. 8.91	10. 10.49	2. 2.48
2197	Guaranteed Found	1.23 1.23	9. 8.96	10. 10.58	2. 2.16
2048	Guaranteed Found	——— ———	10. 10.02	11. 10.47	8. 8.02

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Listers Agricultural Chemical Works, Newark, N. J.	Lister's 3-6-10 for Potatoes	Binghamton	2445
Listers Agricultural Chemical Works, Newark, N. J.	Lister's U. S. Super-Phosphate	Homer	2195
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Vegetable Compound	Skaneateles	2415
Listers Agricultural Chemical Works, Newark, N. J.	Lister's Wheat and Rye Fertilizer	Atlanta	3035
Listers Agricultural Chemical Works, Newark, N. Y.	Muriate of Potash	Schenectady	2859
Listers Agricultural Chemical Works, Newark, N. J.	Nitrate of Soda	Cortland	2545
Long Island Potato Exchange, Riverhead, N. Y.	Five-Eight-Eight	Mattituck	2394
Lowell Fertilizer Co., Boston, Mass.	Dried Blood	Arkport	3028
Lowell Fertilizer Co., Boston Mass.	Kainit	Stamford	2803
Lowell Fertilizer Co., Boston, Mass.	Lowell Acid Phosphate	Middle Granville	2885
Lowell Fertilizer Co., Boston, Mass.	Lowell Animal Brand for All Crops	Cortland	2158
Lowell Fertilizer Co., Boston, Mass.	Lowell Bone Fertilizer for Corn and Grain	Cortland	2165
Lowell Fertilizer Co., Boston, Mass.	Lowell Bone Fertilizer for Corn, Grain, Grass and Vegetables	Greenport	2365
Lowell Fertilizer Co., Boston, Mass.	Lowell Cereal Fertilizer	Cortland	2162
Lowell Fertilizer Co., Boston, Mass.	Lowell Corn and Vegetable	Cortland	2159
Lowell Fertilizer Co., Boston, Mass.	Lowell Dissolved Bone and Potash	Hoosick Falls	2878

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric acid.		
		Nitrogen.	Available.	Total.	Potash.
2445	Guaranteed Found	2.47 2.62	6. 6.23	7. 8.21	10. 10.36
2195	Guaranteed Found	1.03 1.28	8. 7.66	9. 9.17	2. 2.32
2415	Guaranteed Found	3.29 3.32	8. 8.69	9. 10.21	7. 6.90
3035	Guaranteed Found	1.65 1.77	8. 8.70	9. 9.88	2. 2.34
2859	Guaranteed Found	——— ———	——— ———	——— ———	49. 49.84
2545	Guaranteed Found	15. 15.46	——— ———	——— ———	——— ———
2394	Guaranteed Found	——— 4.50	——— 6.92	——— 8.68	——— 8.88
3028	Guaranteed Found	9.84 10.12	——— ———	——— ———	——— ———
2803	Guaranteed Found	——— ———	——— ———	——— ———	12. 13.42
2885	Guaranteed Found	——— ———	14. 14.33	15. 15.71	——— ———
2158	Guaranteed Found	2.46 2.46	8. 8.47	9. 9.17	4. 4.02
2165	Guaranteed Found	1.64 1.51	8. 7.76	9. 8.88	3. 2.70
2365	Guaranteed Found	1.64 1.86	8. 8.54	9. 10.50	3. 2.94
2162	Guaranteed Found	.82 .95	7. 7.01	8. 7.91	1. 1.22
2159	Guaranteed Found	3.28 3.30	8. 8.06	9. 9.	7. 7.92
2878	Guaranteed Found	1.64 1.68	9. 9.32	10. 11.50	2. 2.28

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Lowell Fertilizer Co., Boston, Mass.	Lowell Empress Brand for Corn, Potatoes and Grain	Cortland	2164
Lowell Fertilizer Co., Boston, Mass.	Lowell Grain Phosphate	Stamford	2598
Lowell Fertilizer Co., Boston, Mass.	Lowell Grass Mixture for Top Dressing & Lawns	Salem	2879
Lowell Fertilizer Co., Boston, Mass.	Lowell Ground Bone	Windsor	2589
Lowell Fertilizer Co., Boston, Mass.	Lowell Ground Bone	Gloversville	2857
Lowell Fertilizer Co., Boston, Mass.	Lowell Market Garden Manure	Slingerland	2270
Lowell Fertilizer Co., Boston, Mass.	Lowell Potato Grower with 10 per ct. Potash	Cobleskill	2740
Lowell Fertilizer Co., Boston, Mass.	Lowell Potato Manure	Chenango Forks	2441
Lowell Fertilizer Co., Boston, Mass.	Lowell Potato Phosphate	Cortland	2163
Lowell Fertilizer Co., Boston, Mass.	Lowell Soluble Phosphate	Urlton	2257
Lowell Fertilizer Co., Boston, Mass.	Lowell Special Potato Fertilizer with 10 per ct. Potash	Slingerland	2269
Lowell Fertilizer Co., Boston, Mass.	Lowell Sterling Phosphate	Cortland	2161
Lowell Fertilizer Co., Boston, Mass.	Lowell Vegetable and Grain Fertilizer	Cortland	2160
Lowell Fertilizer Co., Boston, Mass.	Muriate of Potash	Stamford	2802
Lowell Fertilizer Co., Boston, Mass.	Muriate of Potash	Middle Granville	2886
Lowell Fertilizer Co., Boston, Mass.	Nitrate of Soda	Middle Granville	2887

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric acid.		
		Nitrogen.	Available.	Total.	Potash.
2164	Guaranteed Found	1.24 1.28	7. 6.72	8. 7.19	2. 2.42
2598	Guaranteed Found	——— ———	10. 9.30	11. 10.	8. 6.99
2879	Guaranteed Found	4.10 4.08	7. 7.18	8. 8.42	6. 6.76
2589	Guaranteed Found	2.46 2.50	——— ———	23. 27.67	——— ———
2857	Guaranteed Found	2.46 2.56	——— ———	23. 27.24	——— ———
2270	Guaranteed Found	4.10 3.86	7. 7.80	8. 8.85	6. 6.78
2740	Guaranteed Found	3.28 3.23	6. 6.01	7. 7.08	10. 10.02
2441	Guaranteed Found	1.64 2.03	7. 6.96	8. 7.93	4. 4.42
2163	Guaranteed Found	2.46 2.44	8. 8.36	9. 8.82	6. 5.82
2257	Guaranteed Found	——— ———	12. 12.53	13. 13.43	——— ———
2269	Guaranteed Found	2.40 2.45	6. 6.32	7. 6.92	10. 9.92
2161	Guaranteed Found	.82 .94	8. 8.70	9. 10.03	4. 3.98
2160	Guaranteed Found	1.64 1.61	8. 7.66	9. 9.39	10. 10.48
2802	Guaranteed Found	——— ———	——— ———	——— ———	50. 53.18
2886	Guaranteed Found	——— ———	——— ———	——— ———	50. 50.44
2887	Guaranteed Found	15. 15.26	——— ———	——— ———	——— ———

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Ludlam Co., Frederick, New York, N. Y.	Ludlam's A. B. F. Fertilizer	Orient	2651
Ludlam Co., Frederick, New York, N. Y.	Ludlam's Antler Fertilizer	Calverton	2345
Ludlam Co., Frederick, New York, N. Y.	Ludlam's Cecrop's Fertilizer	Riverhead	2327
Ludlam Co., Frederick, New York, N. Y.	Ludlam's Palmetto Fertilizer	Greenwich	2874
Ludlam Co., Frederick, New York, N. Y.	Ludlam's P. G. Phosphate	Greenwich	2876
Ludlam Co., Frederick, New York, N. Y.	Ludlam's Pure Ground Bone	Babylon	2243
Ludlam Co., Frederick, New York, N. Y.	Ludlam's Special Potato Fertilizer	Little Neck	2241
Ludlam Co., Frederick, New York, N. Y.	Nitrate of Soda	Middle Falls	2877
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	Mapes General Crop Brand	Binghamton	2041
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	Mapes Grass and Grain Spring Top-Dressing	Orient	2659
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	Mapes Grain Brand	Honeoye Falls	3168
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	Pure Ground Bone	Bedford Hills	3104
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Average Soil Complete Manure	Jamesport	2306
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Cauliflower and Cabbage Manure	Riverhead	2380
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Cereal Brand	Utica	2696

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2651	Guaranteed	1.65	8.	9.	2.
	Found	1.66	8.85	9.77	2.16
2345	Guaranteed	3.29	6.	7.	10.
	Found	3.77	6.01	7.98	9.88
2327	Guaranteed	3.29	7.	8.	7.
	Found	3.29	7.34	8.22	7.10
2874	Guaranteed	.82	8.	9.	4.
	Found	1.08	8.17	9.52	4.52
2876	Guaranteed	——	10.	11.	6.
	Found	——	9.41	11.36	6.68
2243	Guaranteed	2.47	——	22.88	——
	Found	2.52	——	23.43	——
2241	Guaranteed	2.47	8.	9.	6.
	Found	2.41	8.18	9.73	6.68
2877	Guaranteed	15.	——	——	——
	Found	15.42	——	——	——
2041	Guaranteed	1.65	8.	10.	2.
	Found	1.60	7.72	9.45	3.02
2659	Guaranteed	4.94	5.	6.	7.
	Found	4.90	6.36	7.89	7.80
3168	Guaranteed	.82	8.	——	4.
	Found	.78	8.19	9.19	4.68
3104	Guaranteed	2.47	——	20.	——
	Found	2.50	——	26.45	——
2306	Guaranteed	4.12	7.	8.	5.
	Found	4.27	7.47	8.25	5.66
2380	Guaranteed	4.12	6.	6.	6.
	Found	4.28	6.04	7.17	6.48
2696	Guaranteed	1.65	6.	8.	3.
	Found	1.90	6.11	8.	3.62

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Complete Manure "A" Brand	Jamesport	2307
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Complete Manure for General Use	Southold	2666
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Complete Manure 10 Per Cent Potash	Binghamton	2040
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Corn Manure	Orient	2658
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Dissolved Bone	New York	2316
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Economical Potato Manure	Baldwinsville	2554
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Lawn-Top Dressing	Utica	2697
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Potato Manure	Mt. Kisco	2896
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Potato Manure (L. I. Special)	New York	2315
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Tobacco Manure (Wrapper Brand)	Elmira	3013
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Tobacco Starter Improved	Baldwinsville	2553
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Top Dresser Improved Full Strength	Jamesport	2305
The Mapes Formula & Peruvian Guano Co., New York, N. Y.	The Mapes Vegetable Manure or Complete Manure for Light Soils	Orient	2657

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2307	Guaranteed Found	2.47 2.71	10. 8.68	12. 11.93	2.50 2.80
2666	Guaranteed Found	3.29 3.73	8. 8.56	10. 10.02	4. 5.06
2040	Guaranteed Found	2.06 2.15	3. 4.06	5. 5.81	10. 9.90
2658	Guaranteed Found	2.47 2.56	8. 8.90	10. 10.29	6. 5.86
2316	Guaranteed Found	2.06 2.37	12. 15.49	—— 17.15	—— ——
2554	Guaranteed Found	3.29 3.30	4. 5.07	6. 6.48	8. 8.86
2697	Guaranteed Found	2.47 2.64	2. 3.58	3.50 4.47	2.50 3.20
2896	Guaranteed Found	3.71 3.37	8. 8.40	8. 9.40	6. 6.42
2315	Guaranteed Found	3.29 3.56	4. 5.30	6. 6.92	7. 7.90
3013	Guaranteed Found	6.18 6.48	—— ——	4.50 5.60	10.50 9.74
2553	Guaranteed Found	4.12 4.51	6. 8.91	8. 13.86	1. 1.14
2305	Guaranteed Found	9.88 9.62	5. 7.19	8. 8.03	4. 4.30
2657	Guaranteed Found	4.94 5.00	6. 7.93	8. 8.61	6. 7.14

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Martin Co., D. B., Philadelphia, P.	Martin's Blood Tankage and Potash	Hempstead	1793
Martin Co., D. B., Philadelphia, Pa.	Martin's Dissolved Organic Compound	Syracuse	2818
Martin Co., D. B., Philadelphia, Pa.	Martin's Gilt Edge Potato Manure	Syracuse	2820
Martin Co., D. B., Philadelphia, Pa.	Martin's High Grade Potato	Syracuse	2823
Martin Co., D. B., Philadelphia, Pa.	Martin's One-Eight-Four	Syracuse	2817
Martin Co., D. B., Philadelphia, Pa.	Martin's Potash and Soluble Phosphate	Homer	2193
Martin Co., D. B., Philadelphia, Pa.	Martin's Potash and Soluble Phosphate	Syracuse	2819
Martin Co., D. B., Philadelphia, Pa.	Martin's Potash and Soluble Phosphate No. 2	Stanley	3172
Martin Co., D. B., Philadelphia, Pa.	Martin's Prize Potato	Homer	2192
Martin Co., D. B., Philadelphia, Pa.	Martin's Prize Potato	Syracuse	2821
Martin Co., D. B., Philadelphia, Pa.	Martin's Pure Ground Bone	Hempstead	1796
Martin Co., D. B., Philadelphia, Pa.	Martin's Pure Raw Bone	Hempstead	1795
Martin Co., D. B., Philadelphia, Pa.	Martin's Special Compound	Homer	2194
Martin Co., D. B., Philadelphia, Pa.	Martin's Special Compound	Syracuse	2822
Martin Co., D. B., Philadelphia, Pa.	Martin's Special Potato Manure	Stanley	3173
Martin Co., D. B., Philadelphia, Pa.	Martin's Truckers Guano	Hempstead	1794
Mauthe, John, Dunkirk, N. Y.	Animal Tankage	Dunkirk	3177

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
1793	Guaranteed Found	4.11 3.95	8. 8.23	—— 8.83	7. 7.58
2818	Guaranteed Found	1.03 1.02	9. 7.92	—— 9.20	2. 2.48
2820	Guaranteed Found	2.47 2.42	7. 7.61	—— 8.52	10. 11.32
2823	Guaranteed Found	3.30 3.17	8. 8.22	—— 9.08	10. 11.28
2817	Guaranteed Found	.82 .86	8. 8.14	—— 8.98	4. 4.24
2193	Guaranteed Found	—— ——	10. 9.89	—— 10.25	8. 7.09
2819	Guaranteed Found	—— ——	12. 12.46	—— 12.68	5. 4.78
3172	Guaranteed Found	—— ——	10. 9.71	—— 10.07	8. 7.36
2192	Guaranteed Found	1.65 1.82	8. 7.49	—— 9.18	10. 11.56
2821	Guaranteed Found	1.65 1.63	8. 8.16	—— 9.34	10 10.84
1796	Guaranteed Found	1.65 1.73	—— ——	22.90 23.25	—— ——
1795	Guaranteed Found	3.70 3.94	—— ——	21. 24.13	—— ——
2194	Guaranteed Found	1.65 1.72	8. 8.49	—— 9.07	5. 5.16
2822	Guaranteed Found	1.65 1.60	8. 8.27	—— 9.45	5. 5.18
3173	Guaranteed Found	.82 .83	8. 8.22	—— 8.75	5. 5.50
1794	Guaranteed Found	3.29 3.40	8. 8.56	—— 9.27	7. 8.06
3177	Guaranteed Found	2. 3.03	2. 12.78	—— 21.01	—— ——

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
McCoy, Geo. E., Peekskill, N. Y.	An Honest Fertilizer	Peekskill	3114
The Mitchell Fertilizer Co., Bremley, N. J.	Mitchell's Alkaline Bone	Kinderhook	2267
The Mitchell Fertilizer Co., Bremley, N. J.	Mitchell's Vegetable Fertilizer	Kinderhook	2268
Mittenmaier Fertilizer Co., Rome, N. Y.	Super Phosphate	Sherburne	2536
Moller & Co., Maspeth, L. I.	Champion No. 1 Pure Bone Fertilizer	Maspeth	3063
Moller & Co., Maspeth, L. I.	Champion No. 2 Pure Bone Fertilizer	Maspeth	3064
Munroe & Sons, Geo. L., Oswego, N. Y.	Pure Unleached Wood Ashes	Centervillage	2587
Nassau Fertilizer Co., New York, N. Y.	Common Sense Potato Manure	Kingston	2291
Nassau Fertilizer Co., New York, N. Y.	Corn Fertilizer	Kingston	2289
Nassau Fertilizer Co., New York, N. Y.	General Favorite	Kingston	2288
Nassau Fertilizer Co., New York, N. Y.	Grass and Grain Fertilizer	Kingston	2287
Nassau Fertilizer Co., New York, N. Y.	Potash and Phosphate	Boonville	2693
Nassau Fertilizer Co., New York, N. Y.	Special Potato Fertilizer	Kingston	2286
Nassau Fertilizer Co., New York, N. Y.	Ten & Eight Special	Copenhagen	2681
Nassau Fertilizer Co., New York, N. Y.	Wheat and Grass Grower	Kingston	2290
The National Fertilizer Co., New York, N. Y.	National Complete Root and Grain Fertilizer	Calverton	2362
The National Fertilizer Co., New York, N. Y.	National Complete Root Fertilizer "Special"	Calverton	2346

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric acid.		
		Nitrogen.	Available.	Total.	Potash.
3114	Guaranteed Found	4.25 6.	—— ——	12.25 17.54	—— ——
2267	Guaranteed Found	1.65 1.79	8. 8.39	9. 10.45	2. 2.44
2268	Guaranteed Found	3. 3.	8. 8.52	9. 10.13	4. 4.28
2536	Guaranteed Found	2. 2.42	8. 7.93	—— 9.12	3. 3.48
3063	Guaranteed Found	2.88 3.62	7. 8.99	—— 10.83	6. 7.62
3064	Guaranteed Found	3.30 3.65	7. 9.30	—— 11.52	5. 5.60
2587	Guaranteed Found	—— ——	.25 .53	.50 1.08	1. 1.72
2291	Guaranteed Found	1.65 1.67	8. 8.08	9. 9.45	4. 4.40
2289	Guaranteed Found	1.65 2.66	8. 8.38	9. 10.15	2. 4.28
2288	Guaranteed Found	.82 .90	8. 8.40	9. 10.20	4. 4.04
2287	Guaranteed Found	—— ——	10. 10.48	11. 11.48	2. 2.24
2693	Guaranteed Found	—— ——	10. 10.26	11. 10.75	5. 4.96
2286	Guaranteed Found	1.65 1.76	8. 8.18	9. 9.42	10. 10.60
2681	Guaranteed Found	—— ——	10. 10.15	11. 10.58	8. 8.
2290	Guaranteed Found	.82 .95	8. 8.28	9. 10.08	2. 2.34
2362	Guaranteed Found	3.29 3.47	8. 8.24	9. 8.78	6. 6.08
2346	Guaranteed Found	3.29 3.35	8. 8.23	9. 9.03	7. 7.38

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The National Fertilizer Co., New York, N. Y.	National XXX Fish and Potash	East Marion	2398
Natural Guano Co., Aurora, Ill.	Sheeps Head Brand Pulverized Sheep Manure	Skaneateles	2414
Natural Guano Co., Aurora, Ill.	Pulverized Sheep Manure	Silver Creek	2755
Newburgh Rendering Co., Newburgh, N. Y.	Pure Meat and Bone Fertilizer	Newburgh	2715
New England Fertilizer Co., Boston, Mass.	New England Grain and Vegetable Fertilizer	Moravia	2513
New England Fertilizer Co., Boston, Mass.	New England Potato Grower	Moravia	2514
New England Fertilizer Co., Boston, Mass.	New England Standard Phosphate	Moravia	2515
Newhof & Son, L., Albany, N. Y.	Pure Fertilizer	Albany	2720
The Niantic Menhaden Oil & Guano Co., South Lyme, Conn.	Acidulated Fish Guano	Peconic	2665
The Niantic Menhaden Oil & Guano Co., South Lyme, Conn.	Bone, Fish and Potash	Laurel	2374
The Niantic Menhaden Oil & Guano Co., South Lyme, Conn.	Dry Ground Fish Guano	Orient	2652
The Niantic Menhaden Oil & Guano Co., South Lyme, Conn.	Potato and Vegetable Manure	Jamesport	2308
Nitrate Agencies Co., New York, N. Y.	Basic Slag (Thomas Phosphate Powder)	Albion	2985
Nitrate Agencies Co., New York, N. Y.	Genuine German Kainit	Delhi	2830
Nitrate Agencies Co., New York, N. Y.	Genuine German Kainit	Albion	2984

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2398	Guaranteed Found	2.47 2.71	5. 5.09	6. 5.85	3. 2.86
2414	Guaranteed Found	2.25 2.39	1.50 .99	1.75 1.18	1.50 2.08
2755	Guaranteed Found	2.25 3.37	1.50 1.24	1.75 1.32	1.50 2.
2715	Guaranteed Found	4. 5.65	—— ——	16. 16.91	—— ——
2513	Guaranteed Found	1.64 1.65	8. 8.02	9. 9.72	10. 10.06
2514	Guaranteed Found	2.46 2.74	6. 6.09	7. 6.54	10. 10.06
2515	Guaranteed Found	.82 .94	8. 8.30	9. 9.53	4. 4.04
2720	Guaranteed Found	7. 6.43	—— ——	9. 13.25	—— ——
2665	Guaranteed Found	3.30 4.32	2.50 6.03	3.50 6.91	—— ——
2374	Guaranteed Found	2.46 3.17	5. 5.66	6. 7.18	3. 6.52
2652	Guaranteed Found	6.59 7.43	2.50 4.93	6. 5.49	—— ——
2308	Guaranteed Found	2.50 2.94	7. 9.18	8. 9.42	4. 4.80
2985	Guaranteed Found	—— ——	—— ——	17. 16.69	—— ——
2830	Guaranteed Found	—— ——	—— ——	—— ——	12. 13.54
2984	Guaranteed Found	—— ——	—— ——	—— ——	12. 13.18

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Nitrate Agencies Co., New York, N. Y.	Ground Bone	New Paltz	3122
Nitrate Agencies Co., New York, N. Y.	Ground Tankage	Cutchogue	2321
Nitrate Agencies Co., New York, N. Y.	High Grade Acid Phosphate	Baldwinsville	2558
Nitrate Agencies Co., New York, N. Y.	Muriate of Potash	Cutchogue	2323
Nitrate Agencies Co., New York, N. Y.	Nitrate of Soda	Cutchogue	2322
Nitrate Agencies Co., New York, N. Y.	Sulphate of Potash	Delhi	2828
The Patapsco Guano Co., Baltimore, Md.	Nitrate of Soda	Hamden	2595
The Patapsco Guano Co., Baltimore, Md.	Patapsco Alkaline Plant Food	Oxford	2189
The Patapsco Guano Co., Baltimore, Md.	Patapsco Coon Brand Guano	Oxford	2187
The Patapsco Guano Co., Baltimore, Md.	Patapsco Empire Alkaline Bone	Oxford	2186
The Patapsco Guano Co., Baltimore, Md.	Patapsco Fish and Potash Guano	Sharon Center	2862
The Patapsco Guano Co., Baltimore, Md.	Patapsco Grain and Grass Producer	Hamden	2594
The Patapsco Guano Co., Baltimore, Md.	Patapsco O. K. Phosphate	Oxford	2190
The Patapsco Guano Co., Baltimore, Md.	Patapsco Peerless Potato Guano	Stamford	2599
The Patapsco Guano Co., Baltimore, Md.	Patapsco Prolific Potato Phosphate	Hobart	2838
The Patapsco Guano Co., Baltimore, Md.	Patapsco Pure Dissolved Phosphate	Stamford	2801
The Patapsco Guano Co., Baltimore, Md.	Patapsco Soluble Phosphate and Potash	Stamford	2600

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
3122	Guaranteed Found	2.46 2.43	—— ——	22.88 22.31	—— ——
2321	Guaranteed Found	5.75 5.73	—— ——	13. 13.65	—— ——
2558	Guaranteed Found	—— ——	16. 15.67	—— 17.38	—— ——
2323	Guaranteed Found	—— ——	—— ——	—— ——	50. 51.80
2322	Guaranteed Found	15. 15.58	—— ——	—— ——	—— ——
2828	Guaranteed Found	—— ——	—— ——	—— ——	48. 50.80
2595	Guaranteed Found	15. 15.16	—— ——	—— ——	—— ——
2189	Guaranteed Found	—— ——	8. 8.21	9. 8.67	5. 5.10
2187	Guaranteed Found	.82 .83	9. 9.62	10. 10.88	3. 3.28
2186	Guaranteed Found	—— ——	12. 12.54	13. 13.13	5. 5.08
2862	Guaranteed Found	2.06 2.90	6. 6.82	7. 8.61	2. 1.65
2594	Guaranteed Found	.82 .93	8. 8.16	9. 9.49	4. 4.02
2190	Guaranteed Found	.82 .98	8. 8.32	9. 9.58	2. 2.20
2599	Guaranteed Found	3.29 3.20	6. 6.39	7. 8.36	10. 10.12
2838	Guaranteed Found	3.29 3.24	8. 8.41	9. 11.11	7. 8.
2801	Guaranteed Found	—— ——	14. 14.75	15. 16.13	—— ——
2600	Guaranteed Found	—— ——	10. 10.07	11. 10.87	2. 2.62

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Patapsco Guano Co., Baltimore, Md.	Patapsco Special Potato Guano	Oxford	2188
The Patapsco Guano Co., Baltimore, Md.	Patapsco Superior Alkaline Manure	Oxford	2191
The Patapsco Guano Co., Baltimore, Md.	Patapsco Vegetable and Corn Fertilizer	Sherburne	2535
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Acid Phosphate	Buffalo	3181
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Big Bonanza	Fancher	2143
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Economy	Colton	2674
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Empire 10%	Penn Yan	3044
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Four Fold	Penn Yan	3045
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Grain and Grass	Orchard Park	2613
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Potato and Truck Manure	Orchard Park	2612
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Standard Phosphate	Clarence	2778
The Pennsylvania Fertilizer Co., Buffalo, N. Y.	Vegetable and Vine	Orchard Park	2611
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Insula Guano for All Crops	Cherry Valley	2743
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Levering's Harvest Queen	Chenango Bridge	2444
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Levering's Standard	Syracuse	2731
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	New York Vegetable Manure	Cherry Valley	2745
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Nitrate of Soda	Syracuse	2734

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
2188	Guaranteed Found	1.65 1.72	8. 8.33	9. 9.60	10. 10.68
2191	Guaranteed Found	——— ———	10. 10.31	11. 10.80	8. 8.18
2535	Guaranteed Found	1.65 1.76	8. 8.58	9. 10.15	4. 3.94
3181	Guaranteed Found	——— ———	12. 15.30	13. 15.92	——— ———
2143	Guaranteed Found	.8 1.25	8. 8.37	9. 10.55	4. 4.74
2674	Guaranteed Found	1.6 1.64	8. 9.	9. 9.86	4. 4.46
3044	Guaranteed Found	1.6 1.79	8. 8.61	9. 9.33	10. 8.25
3045	Guaranteed Found	.8 .87	8. 10.51	9. 11.47	2. 2.18
2613	Guaranteed Found	——— ———	10. 10.36	11. 11.66	2. 2.12
2612	Guaranteed Found	1.6 1.85	8. 8.18	9. 10.08	6. 6.62
2778	Guaranteed Found	——— ———	10. 10.22	11. 11.59	6. 6.10
2611	Guaranteed Found	.8 .94	10. 9.57	11. 11.51	8. 8.90
2743	Guaranteed Found	.42 .80	7. 7.66	——— 8.33	2. 1.89
2444	Guaranteed Found	.82 .85	8. 8.28	——— 9.03	2. 2.12
2731	Guaranteed Found	1.65 1.62	8. 8.20	——— 8.70	3. 5.82
2745	Guaranteed Found	3.29 3.21	8. 8.13	——— 8.48	6. 5.74
2734	Guaranteed Found	15.23 15.22	——— ———	——— ———	——— ———

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Nitrate of Soda	Clyde	2972
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Banner Brand	Syracuse	2730
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Bone Meal	Holland	3154
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Farmers' Favorite	Altamont	2275
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont 14% Acid Phosphate	Schoharie	2737
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Market Garden	Canandaigua	2791
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont New York Cabbage & Potato Guano	Chenango Bridge	2443
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Oats and Grass Guano	Altamont	2276
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Pea and Bean Guano	Schoharie	2728
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Perfection Guano	Ithaca	2569
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Special Mixture	Chenango Bridge	2442
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Wheat and Corn Guano	Canandaigua	2790
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Piedmont Wheat Compound	Syracuse	2733
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Raw and Dissolved Bone	Holland	3155
Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Thomas Phosphate Powder	Albion	2139
Pine, B. J., East Williston, L. I.	Pine's No. 1 Star Raw Bone Super-Phosphate	East Williston	2228
Pine, B. J., East Williston, L. I.	Pine's No. 2 Star Raw Bone Super-Phosphate Complete Manure	East Williston	2229

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2972	Guaranteed Found	15.23 15.13	——— ———	——— ———	——— ———
2730	Guaranteed Found	3.29 3.25	6. 7.30	——— 8.04	10. 10.42
3154	Guaranteed Found	3.29 5.14	——— ———	21. 21.28	——— ———
2275	Guaranteed Found	.82 1.	8. 9.35	——— 10.08	4. 4.16
2737	Guaranteed Found	——— ———	14. 15.18	——— 15.44	——— ———
2791	Guaranteed Found	2.47 2.37	8. 8.31	——— 9.08	6. 4.84
2443	Guaranteed Found	1.65 1.85	8. 8.50	——— 8.74	10. 10.64
2276	Guaranteed Found	——— ———	10. 10.78	——— 10.93	2. 2.64
2728	Guaranteed Found	.82 .94	7. 8.77	——— 9.67	9. 9.68
2569	Guaranteed Found	1.65 1.48	8. 8.44	——— 8.91	5. 5.68
2442	Guaranteed Found	——— ———	10. 10.17	——— 10.28	8. 8.40
2790	Guaranteed Found	1.65 1.88	8. 7.89	——— 8.31	2. 2.68
2733	Guaranteed Found	——— ———	12. 12.10	——— 12.53	5. 5.92
3155	Guaranteed Found	2.49 2.50	——— ———	——— 17.97	——— ———
2139	Guaranteed Found	——— ———	15. *	17. 17.26	——— ———
2228	Guaranteed Found	2.47 2.42	6. 6.55	7. 7.50	7. 7.
2229	Guaranteed Found	2.25 2.38	6. 6.44	7. 7.	3. 3.16

*No official method for determining available P_2O_5 in this sample.

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Pioneer Fertilizer Co., Cleveland, O.	Pioneer 1–5–10 Fertilizer	West Henrietta	2978
Pioneer Fertilizer Co., Cleveland, O.	Pioneer 2–8–10 Fertilizer	West Henrietta	2977
The Pulverized Manure Co., Chicago, Ill.	Wizard Brand Concentrated Plant Food	Batavia	2481
The Pulverized Manure Co., Chicago, Ill.	Wizard Brand Pulverized Cattle Manure	Utica	2695
The Pulverized Manure Co., Chicago, Ill.	Wizard Brand Pulverized Sheep Manure	Auburn	2551
Quaker City Poudrette Co., Philadelphia, Pa.	Strictly Pure Quaker City Poudrette	Elmira	3021
Ramer, Catherine T., Delhi, N. Y.	Accommodation Mixture Oats	Delhi	2831
Ramer, Catherine T., Delhi, N. Y.	Accommodation Mixture Potato	Delhi	2829
Ramer, Catherine T., Delhi, N. Y.	Accommodation Mixture Silo Corn	Delhi	2832
Rasin-Monumental Co., Baltimore, Md.	High Grade Ground Fish	Albion	2123
Rasin-Monumental Co., Baltimore, Md.	Muriate of Potash	Albion	2120
Rasin-Monumental Co., Baltimore, Md.	Rasin's Acid Phosphate	Albion	2114
Rasin-Monumental Co., Baltimore, Md.	Rasin's All Crop Guano	Homer	2199
Rasin-Monumental Co., Baltimore, Md.	Rasin's Bone and Potash Fertilizer	Delanson	2724
Rasin-Monumental Co., Baltimore, Md.	Rasin's Empire Guano	Ames	2861
Rasin-Monumental Co., Baltimore, Md.	Rasin's Genesee Valley Root Manure	Skaneateles	2420
Rasin-Monumental Co., Baltimore, Md.	Rasin's Genuine German Kainit	Skaneateles	2422

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2978	Guaranteed Found	.82 .85	5. 5.67	6. 5.99	10. 10.26
2977	Guaranteed Found	1.65 1.63	8. 8.86	9. 9.69	10. 10.66
2481	Guaranteed Found	3. 3.70	6. 6.75	—— 7.01	2. 3.76
2695	Guaranteed Found	1.8 1.75	1. .79	—— .93	1. .92
2551	Guaranteed Found	1.8 2.28	1. 1.10	—— 1.23	1. 2.22
3021	Guaranteed Found	1.64 1.	—— ——	4. 2.35	1. .11
2831	Guaranteed Found	—— 1.68	—— 7.74	—— 8.63	—— 16.20
2829	Guaranteed Found	—— 2.88	—— 8.48	—— 9.10	—— 9.56
2832	Guaranteed Found	—— 1.72	—— 7.14	—— 8.02	—— 14.32
2123	Guaranteed Found	8.23 8.92	—— ——	—— ——	—— ——
2120	Guaranteed Found	—— ——	—— ——	—— ——	48. 47.72
2114	Guaranteed Found	—— ——	14. 14.29	15. 16.10	—— ——
2199	Guaranteed Found	.82 .85	8. 8.13	9. 10.38	5. 5.16
2724	Guaranteed Found	—— ——	10. 10.10	11. 11.20	2. 2.24
2861	Guaranteed Found	1.65 1.72	8. 8.09	9. 10.16	2. 2.60
2420	Guaranteed Found	.82 1.14	8. 8.14	9. 9.43	10. 9.96
2422	Guaranteed Found	—— ——	—— ——	—— ——	12. 13.

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Rasin-Monumental Co., Baltimore, Md.	Rasin's Gold Standard	Cobleskill	2738
Rasin-Monumental Co., Baltimore, Md.	Rasin's High Grade Bone and Potash	Albion	2121
Rasin-Monumental Co., Baltimore, Md.	Rasin's Irish Potato Special	Groton	2507
Rasin-Monumental Co., Baltimore, Md.	Rasin's IXL Fertilizer	Homer	2200
Raisn-Monumental Co., Baltimore, Md.	Rasin's National Crop Compound	Albion	2118
Rasin-Monumental Co., Baltimore, Md.	Rasin's Special Fish and Potash Mixture	Albion	2122
Rasin-Monumental Co., Baltimore, Md.	Rasin's Special Fish and Potash Mixture	Linwood	3000
Rasin-Monumental Co., Baltimore, Md.	Rasin's United Grain Grower	Ames	2860
Rasin-Monumental Co., Baltimore, Md.	Rasin's Vegetable Special	Homer	2198
Rasin-Monumental Co., Baltimore, Md.	Rasin's Wheat and Truck Mixture	Albion	2115
Rasin-Monumental Co., Baltimore, Md.	Rasin's XXX Fertilizer	Albion	2117
Reading Bone Fertilizer Co., Reading, Pa.	Alkaline Phosphate and Potash	Carthage	2683
Reading Bone Fertilizer Co., Reading, Pa.	Alkaline Phosphate and Potash	Warsaw	2994
Reading Bone Fertilizer Co., Reading, Pa.	Farmer's Tankage and Potash for Corn, Grain and Grass	Churchville	2483
Reading Bone Fertilizer Co., Reading, Pa.	Gilt Edge Potato and Tobacco Grower	Bergen	2485
Reading Bone Fertilizer Co., Reading, Pa.	High Grade Potash Mixture	Bergen	2486

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
2738	Guaranteed Found	2.47 2.50	6. 6.51	7. 8.67	6. 6.20
2121	Guaranteed Found	—— ——	12. 12.	13. 13.13	5. 5.80
2507	Guaranteed Found	3.29 3.38	7. 7.44	8. 8.73	8. 8.98
2200	Guaranteed Found	.82 .97	9. 11.59	10. 11.97	3. 3.34
2118	Guaranteed Found	.82 .94	8. 7.47	9. 9.98	4. 5.16
2122	Guaranteed Found	3.29 3.31	6. 5.89	7. 8.64	10. 9.64
3000	Guaranteed Found	3.29 3.30	6. 7.07	7. 8.98	10. 10.02
2860	Guaranteed Found	.82 1.06	8. 8.54	9. 10.41	2. 2.88
2198	Guaranteed Found	1.65 1.87	8. 7.80	9. 9.50	10. 10.28
2115	Guaranteed Found	—— ——	10. 9.95	11. 10.91	8. 9.38
2117	Guaranteed Found	1.65 1.70	8. 8.05	9. 10.24	5. 4.86
2683	Guaranteed Found	—— ——	8. 8.04	9. 8.71	5. 5.46
2994	Guaranteed Found	—— ——	8. 8.65	9. 8.93	5. 5.58
2483	Guaranteed Found	.82 1.36	8. 7.56	9. 9.19	4. 4.94
2485	Guaranteed Found	1.64 1.52	7. 7.63	8. 8.79	10. 9.88
2486	Guaranteed Found	—— ——	10. 9.91	11. 10.73	10. 11.52

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Reading Bone Fertilizer Co., Reading, Pa.	Neverfail Crop Grower	Warsaw	2992
Reading Bone Fertilizer Co., Reading, Pa.	Reading All Crop Special	Honeoye Falls	3167
Reading Bone Fertilizer Co., Reading, Pa.	Reading Prize Winner	Churchville	2482
Reading Bone Fertilizer Co., Reading, Pa.	Reading Special Potato and Tobacco Grower	Warsaw	2995
Reading Bone Fertilizer Co., Reading, Pa.	Reading Ten and Eight	Hamlin	2979
Rochester Tallow Co., Inc., Rochester, N. Y.	Dry Blood	Rochester	2645
Rochester Tallow Co., Inc., Rochester, N. Y.	Dry Tankage	Rochester	2644
Roehr, G., McKownsville, N. Y.	Co-wa-ba	Albany	3125
The Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Bone Base Complete Phosphate	Sharon Springs	2863
The Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Bone Base Fruit or Grass and Grain Fertilizer	Sharon Springs	2866
The Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Bone Base Oats and Top Dressing	Goshen	2294
The Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Bone Base Oats and Top Dressing	Hillsdale	3132
The Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Bone Base Potato Phosphate	Greenwich	2873
The Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Bone Base Soluble Corn and General Crops Manure	Sharon Springs	2865
The Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Bone Base Soluble Potato Manure	Greenwich	2872
The Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Bone Base Strictly Pure Fine Bone	Sharon Springs	2864

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2992	Guaranteed Found	.82 1.60	8. 8.09	9. 9.14	1. 1.96
3167	Guaranteed Found	1.64 1.92	7. 7.35	—— 8.17	5. 5.06
2482	Guaranteed Found	2.47 2.74	9. 9.07	10. 10.10	12. 11.96
2995	Guaranteed Found	.82 .94	6. 6.69	7. 7.10	7. 8.24
2979	Guaranteed Found	—— ——	10. 10.08	11. 10.84	8. 7.90
2645	Guaranteed Found	—— 12.33	—— ——	—— ——	—— ——
2644	Guaranteed Found	—— 5.19	—— ——	—— 16.43	—— ——
3125	Guaranteed Found	.02 .16	—— ——	.01 .11	—— ——
2863	Guaranteed Found	1.50 1.70	7. 7.30	8. 8.82	5. 5.98
2866	Guaranteed Found	2.20 2.54	6.50 9.62	16. 16.10	12. 13.24
2294	Guaranteed Found	8.50 8.63	4.50 7.45	8. 9.67	8. 7.66
3132	Guaranteed Found	8.50 9.31	4.50 6.34	8. 7.87	8. 8.08
2873	Guaranteed Found	2. 2.11	9. 9.99	10. 11.31	5. 6.02
2865	Guaranteed Found	2.50 2.85	6. 7.89	8. 9.70	8. 8.56
2872	Guaranteed Found	5. 4.98	7. 8.64	10. 11.14	5. 6.16
2864	Guaranteed Found	2.85 4.18	—— ——	22. 20.40	—— ——

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Royster Guano Co., F. S., Baltimore, Md.	Muriate of Potash	Wisner	2299
Royster Guano Co., F. S., Baltimore, Md.	Nitrate of Soda	Wisner	2300
Royster Guano Co., F. S., Baltimore, Md.	Royster's Ammoniated Potash Compound	Elba	2773
Royster Guano Co., F. S., Baltimore, Md.	Royster's Ammoniated Superphosphate for Corn	Batavia	2476
Royster Guano Co., F. S., Baltimore, Md.	Royster's Big Yield Potato Producer	Cortland	2171
Royster Guano Co., F. S., Baltimore, Md.	Royster's Big Yield Potato Producer	Attica	2468
Royster Guano Co., F. S., Baltimore, Md.	Royster's Bumper Crop Phosphate	Batavia	2474
Royster Guano Co., F. S., Baltimore, Md.	Royster's Challenge Complete Compound	Batavia	2477
Royster Guano Co., F. S., Baltimore, Md.	Royster's Challenge Complete Compound	Caywood	3185
Royster Guano Co., F. S., Baltimore, Md.	Royster's Champion Crop Compound	Tully	2405
Royster Guano Co., F. S., Baltimore, Md.	Royster's Champion Crop Compound	Caywood	3184
Royster Guano Co., F. S., Baltimore, Md.	Royster's Complete Potato Manure	Riverhead	2372
Royster Guano Co., F. S., Baltimore, Md.	Royster's Complete Potato Manure	Walden	2710
Royster Guano Co., F. S., Baltimore, Md.	Royster's Corn and Hop Special Fertilizer	Middleburg	2735
Royster Guano Co., F. S., Baltimore, Md.	Royster's Fine Ground Bone Meal	Walden	2707
Royster Guano Co., F. S., Baltimore, Md.	Royster's Fish, Flesh and Fowl	Cortland	2170
Royster Guano Co., F. S., Baltimore, Md.	Royster's 14% Acid Phosphate	Owego	2046

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2299	Guaranteed Found	—— ——	—— ——	—— ——	50. 51.60
2300	Guaranteed Found	15. 15.50	—— ——	—— ——	—— ——
2773	Guaranteed Found	.82 1.	9. 8.56	9.50 9.60	7. 7.34
2476	Guaranteed Found	2.47 2.41	9. 8.93	9.50 10.37	2. 2.90
2171	Guaranteed Found	1.65 1.70	5. 4.14	5.50 5.53	10. 11.02
2468	Guaranteed Found	1.65 1.63	5. 4.36	5.50 5.65	10. 11.32
2474	Guaranteed Found	—— ——	8. 8.10	8.50 9.05	5. 5.26
2477	Guaranteed Found	1.65 1.83	8. 7.97	8.50 9.16	6. 6.64
3185	Guaranteed Found	1.65 1.60	8. 8.05	8.50 9.79	6. 6.46
2405	Guaranteed Found	1.65 1.60	8. 7.67	8.50 8.76	4. 4.68
3184	Guaranteed Found	1.65 1.70	8. 7.65	8.50 9.40	4. 5.14
2372	Guaranteed Found	3.29 3.59	6. 6.34	6.50 7.83	10. 8.84
2710	Guaranteed Found	3.29 2.95	6. 6.46	6.50 7.84	10. 9.26
2735	Guaranteed Found	2.06 2.08	8. 7.99	8.50 8.94	3. 3.74
2707	Guaranteed Found	2.47 3.08	—— ——	22.90 23.52	—— ——
2170	Guaranteed Found	1.65 1.82	8. 7.32	8.50 9.38	3. 3.32
2046	Guaranteed Found	—— ——	14. 14.61	14.50 15.38	—— ——

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Royster Guano Co., F. S., Baltimore, Md.	Royster's Gold Seal Potato and Tobacco Special	Owego	2047
Royster Guano Co., F. S., Baltimore, Md.	Royster's Good Cheer Brand	Orchard Park	2614
Royster Guano Co., F. S., Baltimore, Md.	Royster's Great Grain Grower	Owego	2044
Royster Guano Co., F. S., Baltimore, Md.	Royster's Harvest King Fertilizer	Interlaken	2576
Royster Guano Co., F. S., Baltimore, Md.	Royster's High Grade Potash Mixture	Cortland	2169
Royster Guano Co., F. S., Baltimore, Md.	Royster's High Grade Potash Mixture	Saratoga Spa	3126
Royster Guano Co., F. S., Baltimore, Md.	Royster's High Grade Potato Grower	Gasport	2494
Royster Guano Co., F. S., Baltimore, Md.	Royster's High Grade 16% Acid Phosphate	Florida	2295
Royster Guano Co., F. S., Baltimore, Md.	Royster's Imperial Formula	Tully	2404
Royster Guano Co., F. S., Baltimore, Md.	Royster's Imperial Formula	Caywood	3186
Royster Guano Co., F. S., Baltimore, Md.	Royster's Lawn and Meadow Formula	Barker	2983
Royster Guano Co., F. S., Baltimore, Md.	Royster's Peerless Grain and Grass Grower	Hamburg	2623
Royster Guano Co., F. S., Baltimore, Md.	Royster's Pure Raw Bone Meal	North Collins	2631
Royster Guano Co., F. S., Baltimore, Md.	Royster's Seeding Down Special Fertilizer	Carthage	2679
Royster Guano Co., F. S., Baltimore, Md.	Royster's Special Celery Guano	Carthage	2680
Royster Guano Co., F. S., Baltimore, Md.	Royster's Special Fruit and Crop Grower	Owego	2045

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2047	Guaranteed Found	1.65 1.81	8. 7.29	8.50 9.08	10. 10.52
2614	Guaranteed Found	1.03 .98	8. 7.84	8.50 8.46	2. 3.48
2044	Guaranteed Found	.82 1.04	8. 7.20	8.50 8.98	5. 6.36
2576	Guaranteed Found	1.65 1.88	8. 8.15	8.50 9.42	2. 2.38
2169	Guaranteed Found	—— ——	10. 10.57	10.50 11.06	10. 10.18
3126	Guaranteed Found	—— ——	10. 10.06	10.50 10.43	10. 10.22
2494	Guaranteed Found	2.47 2.41	6. 6.	6.50 7.03	10. 10.28
2295	Guaranteed Found	—— ——	16. 16.54	16.50 16.75	—— ——
2404	Guaranteed Found	.82 .88	8. 7.65	8.50 8.83	4. 4.30
3186	Guaranteed Found	.82 .84	8. 8.45	8.50 9.72	4. 4.30
2983	Guaranteed Found	4.11 3.38	6. 6 99	6.50 8.50	2. 3.88
2623	Guaranteed Found	—— ——	10. 9.73	10.50 10.22	2. 1.88
2631	Guaranteed Found	3.70 3.82	—— ——	21.50 21.65	—— ——
2679	Guaranteed Found	.82 1.07	9. 9.14	9.50 10.14	3. 3.10
2680	Guaranteed Found	3.29 3.09	8. 8.68	8.50 10.41	12. 9.62
2045	Guaranteed Found	—— ——	10. 10.01	10.50 11.13	8. 8.06

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Royster Guano Co., F. S., Baltimore, Md.	Royster's Special Potato Guano	Riverhead	2358
Royster Guano Co., F. S., Baltimore, Md.	Royster's Superior Potash Mixture	Walden	2709
Royster Guano Co., F. S., Baltimore, Md.	Royster's Truckers Favorite	Riverhead	2373
Royster Guano Co., F. S., Baltimore, Md.	Royster's Truckers Favorite	Hempstead	3069
Royster Guano Co., F. S., Baltimore, Md.	Royster's Universal Crop Grower	Maine	2542
Royster Guano Co., F. S., Baltimore, Md.	Royster's Universal Truck Fertilizer	Laurel	2310
Royster Guano Co., F. S., Baltimore, Md.	Royster's Wheat, Oats and Barley Fertilizer	Tully	2406
Royster Guano Co., F. S., Baltimore, Md.	Royster's XX Acid Phosphate	Schoharie	2727
Sanderson Fertilizer & Chem. Co., New Haven, Conn.	Sanderson's Atlantic Coast Bone, Fish and Potash Fertilizer	Mattituck	2314
Sanderson Fertilizer & Chem. Co., New Haven, Conn.	Sanderson's Cabbage Fertilizer	Jamaica	2209
Sanderson Fertilizer & Chem. Co., New Haven, Conn.	Sanderson's Special Potato Manure	Mattituck	2313
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Complete Fertilizer with Extra Potash	Barker	2982
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Complete Fertilizer with Extra Potash	Eden Center	2986
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Dissolved Phosphate	Canaseraga	2998
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Dissolved Phosphate with Extra Potash	Collins	2640
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Dissolved Phosphate with Extra Potash	Eden Center	2988

*Manufacturers claim error occurred in printing nitrogen guarantee on bags. It should be 4.94 per ct.

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2358	Guaranteed Found	4.11 4.	7. 6.97	7.50 8.16	7. 6.90
2709	Guaranteed Found	—— ——	12. 12.69	12.50 13.48	5. 4.82
2373	Guaranteed Found	4.94 4.35	8. 8.31	8.50 9.35	5. 5.82
3069	Guaranteed Found	5.76* 4.95	8. 9.58	8.50 10.81	5. 5.02
2542	Guaranteed Found	.82 .88	7. 6.97	7.50 7.78	1. 1.10
2310	Guaranteed Found	3.29 3.32	8. 7.48	8.50 9.16	7. 6.72
2406	Guaranteed Found	.82 .98	8. 8.	8.50 9.13	2. 2.20
2727	Guaranteed Found	—— ——	12. 12.08	12.50 13.38	—— ——
2314	Guaranteed Found	1.67 1.94	4. 5.41	6. 7.38	4. 4.04
2209	Guaranteed Found	4. 4.05	5. 6.65	—— 9.38	5. 4.98
2313	Guaranteed Found	3.30 3.28	7. 7.62	8. 10.27	7. 6.74
2982	Guaranteed Found	1.65 1.82	8. 8.39	9. 10.56	10. 9.60
2986	Guaranteed Found	1.65 1.70	8. 8.77	9. 11.11	10. 9.64
2998	Guaranteed Found	—— ——	14. 14.51	15. 15.02	—— ——
2640	Guaranteed Found	—— ——	10. 9.29	11. 10.79	4. 3.53
2988	Guaranteed Found	—— ——	10. 10.34	11. 11.71	4. 4.38

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Farmers' Favorite	Collins	2641
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Fruit and Vine Fertilizer	Eden Center	2987
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Guano	Middleport	2491
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	High Grade Ground Bone	South Dayton	2952
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Schaal's Corn and Potato	Collins	2639
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Schaal's Standard	Eden Center	2989
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Superior	South Dayton	2953
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Ten and Eight	Middleport	2492
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Ten and Eight	Eagle	3182
Schaal-Sheldon Fertilizer Co., Buffalo, N. Y.	Truckers Manure	South Dayton	2958
Shafer Company, Perry C., Brockport, N. Y.	Shafer's Special Fertilizer	Brockport	3187
Shay Fertilizer Co., C. M., Groton, Conn.	Shay's Potato Fertilizer	Orient	2653
Shay Fertilizer Co., C. M., Groton, Conn.	Shay's Potato with Potash	Orient	2654
Shay Fertilizer Co., C. M., Groton, Conn.	Tankage	Orient	2655
Shoemaker & Co., Ltd., M. L., Philadelphia, Pa.	Swift-Sure Bone Meal	Peconic	2389
Shoemaker & Co., Ltd., M. L., Philadelphia, Pa.	Swift-Sure Guano for Truck, Corn & Onions	Southampton	2669
Shoemaker & Co., Ltd., M. L., Philadelphia, Pa.	Swift-Sure Superphosphate for General Use	Cutchogue	2391

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric acid.		
		Nitrogen.	Available.	Total.	Potash.
2641	Guaranteed	.82	8.	9.	2.
	Found	.91	8.04	10.06	2.08
2987	Guaranteed	2.47	6.	7.	10.
	Found	2.31	6.83	8.64	9.66
2491	Guaranteed	.82	8.	9.	4.
	Found	.91	8.57	10.64	4.68
2952	Guaranteed	3.29	—	20.59	—
	Found	3.29	—	20.37	—
2639	Guaranteed	1.65	8.	9.	4.
	Found	1.73	9.28	10.93	4.08
2989	Guaranteed	1.65	8.	9.	2.
	Found	1.67	8.69	10.47	2.60
2953	Guaranteed	.82	7.	8.	9.
	Found	1.05	7.24	8.77	8.32
2492	Guaranteed	—	10.	11.	8.
	Found	—	10.30	12.12	7.66
3182	Guaranteed	—	10.	11.	8.
	Found	—	10.40	11.91	7.84
2958	Guaranteed	2.47	8.	9.	6.
	Found	2.87	8.15	10.15	6.42
3187	Guaranteed	2.06	8.	9.	5.
	Found	2.01	8.29	9.82	5.16
2653	Guaranteed	3.50	7.50	—	6.
	Found	3.89	7.40	8.61	6.30
2654	Guaranteed	—	—	—	—
	Found	4.01	7.41	8.	8.46
2655	Guaranteed	—	—	—	—
	Found	7.06	6.86	9.63	.64
2389	Guaranteed	4.53	—	20.	—
	Found	4.87	—	21.48	—
2669	Guaranteed	1.65	8.	—	5.
	Found	1.95	9.28	12.06	5.42
2391	Guaranteed	2.88	9.	—	4.50
	Found	2.98	10.56	12.35	5.38

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Shoemaker & Co., Ltd., M. L., Philadelphia, Pa.	Swift-Sure Superphosphate for Potatoes	Southampton	2668
Stappenbeck Bros., Rochester, N. Y.	Concentrated Tankage	Rochester	2976
Stappenbeck, H., Utica, N. Y.	Animal Bone and Potash	Syracuse	2437
Sterling Chemical Co., Cambridge, Mass.	Sterlingworth Plant Tablets	Schenectady	2892
St. Lawrence State Hospital, Ogdensburg, N. Y.	Steamed Table Bone	Ogdensburg	2907
Stockwell Co., J. W., Fillmore, N. Y.	Stockwell Co's Home Mixed 11½–5	Fillmore	3160
Stockwell Co., J. W., Fillmore, N. Y.	Stockwell Co's Home Mixed 4–8–8 Fertilizer	Fillmore	3159
Stockwell Co., J. W., Fillmore, N. Y.	Stockwell Co's Home Mixed 1–10–10 Fertilizer	Fillmore	3162
Stockwell Co., J. W., Fillmore, N. Y.	Stockwell Co's Home Mixed 2–8–10 Fertilizer	Fillmore	3161
Stockwell Co., J. W., Fillmore, N. Y.	Stockwell Co's Home Mixed 2–10½–6 Fertilizer	Fillmore	3163
Stumpp & Walter Co., New York, N. Y.	Emerald Lawn Dressing	New York	2246
Stumpp & Walter Co., New York, N. Y.	S. & W. Co's Bone Fertilizer	New York	2245
Swift & Company, Chicago, Ill.	Riverhead Town Agri. Society Fertilizer Formula No. 1	Riverhead	2328
Swift & Company, Chicago, Ill.	Riverhead Town Agri. Society Fertilizer Formula No. 2	Riverhead	2329
Swift & Company, Chicago, Ill.	Riverhead Town Agri. Society Fertilizer Formula No. 3	Peconic	2388

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2668	Guaranteed Found	2.88 2.82	8. 10.77	—— 13.11	7. 6.70
2976	Guaranteed Found	9. 9.44	—— ——	6. 7.83	—— ——
2437	Guaranteed Found	2. 2.77	8. 11.40	16. 18.92	3.50 5.01
2892	Guaranteed Found	—— 10.97	—— 12.36	—— 12.36	—— 8.72
2907	Guaranteed Found	—— 3.52	—— ——	—— 23.44	—— ——
3160	Guaranteed Found	—— ——	11.50 11.95	—— 13.21	5. 5.04
3159	Guaranteed Found	3.29 3.07	8. 8.52	—— 9.26	8. 7.96
3162	Guaranteed Found	.82 .82	10. 10.37	—— 11.23	10. 10.32
3161	Guaranteed Found	1.65 1.60	8. 8.29	—— 9.09	10. 10.40
3163	Guaranteed Found	1.65 1.65	10.50 10.58	—— 11.50	6. 7.10
2246	Guaranteed Found	3. 3.65	5. 5.98	7. 8.20	6. 7.
2245	Guaranteed Found	3. 4.04	—— ——	20. 22.21	—— ——
2328	Guaranteed Found	4.10 4.31	8. 8.63	—— 9.40	5. 5.86
2329	Guaranteed Found	4.93 5.16	8. 8.05	—— 8.73	5. 6.02
2388	Guaranteed Found	4.10 3.94	8. 8.50	—— 9.12	8. 7.90

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Swift & Company, Chicago, Ill.	Swift's Diamond C Fertilizer	Union	2540
Swift & Company, Chicago, Ill.	Swift's Diamond D Fertilizer	Unadilla	2527
Swift & Company, Chicago, Ill.	Swift's Diamond E Fertilizer	Cortland	2152
Swift & Company, Chicago, Ill.	Swift's Diamond E Fertilizer	Silver Creek	2754
Swift & Company, Chicago, Ill.	Swift's Diamond G Fertilizer	Cortland	2151
Swift & Company, Chicago, Ill.	Swift's Diamond H Fertilizer	Spencer	3041
Swift & Company, Chicago, Ill.	Swift's Early Potatoes and Vegetables Grower	Newark Valley	3008
Swift & Company, Chicago, Ill.	Swift's Garden City Acid Phosphate	Owego	2847
Swift & Company, Chicago, Ill.	Swift's Grain Fertilizer	Owego	2846
Swift & Company, Chicago, Ill.	Swift's High Grade Phosphate and Potash	Romulus	2573
Swift & Company, Chicago, Ill.	Swift's Onion, Potato and Tobacco	Unadilla	2528
Swift & Company, Chicago, Ill.	Swift's Potato, Celery and Onion Grower	Collins	2638
Swift & Company, Chicago, Ill.	Swift's Pulverized Sheep Manure	Burt	2500
Swift & Company, Chicago, Ill.	Swift's Pure Bone Meal	Burt	2499
Swift & Company, Chicago, Ill.	Swift's Pure Diamond B Fertilizer	Burt	2498
Swift & Company, Chicago, Ill.	Swift's Pure Diamond F Fertilizer	Collins	2637
Swift & Company, Chicago, Ill	Swift's Pure Diamond G Fertilizer	Silver Creek	2753

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
			Phosphoric acid.		
		Nitrogen.	Available.	Total.	Potash.
2540	Guaranteed Found	1.65 1.60	8. 8.44	9. 8.89	4. 3.72
2527	Guaranteed Found	2.47 2.48	6. 8.32	7. 8.56	10. 11.84
2152	Guaranteed Found	3.29 2.87	8. 8.41	9. 9.11	7. 7.38
2754	Guaranteed Found	3.29 2.85	8. 8.55	9. 9.98	7. 6.54
2151	Guaranteed Found	—— ——	10. 10.79	11. 10.97	8. 7.78
3041	Guaranteed Found	—— ——	12. 12.21	13. 12.35	5. 5.
3008	Guaranteed Found	3.30 3.05	6. 6.29	7. 6.85	10. 9.80
2847	Guaranteed Found	—— ——	14. 15.72	15. 15.88	—— ——
2846	Guaranteed Found	1.03 1.14	8. 7.92	9. 8.41	2. 2.40
2573	Guaranteed Found	—— ——	10. 9.98	11. 11.39	4. 3.92
2528	Guaranteed Found	1.65 1.60	8. 8.54	9. 9.32	7. 6.96
2638	Guaranteed Found	.82 .88	5. 5.84	6. 6.18	10. 9.34
2500	Guaranteed Found	2.47 3.05	—— ——	2. 3.39	2. 1.55
2499	Guaranteed Found	2.47 2.56	—— ——	24. 25.45	—— ——
2498	Guaranteed Found	2.47 1.99	8. 9.36	9. 10.35	5. 4.64
2637	Guaranteed Found	—— ——	8. 8.03	9. 8.50	3. 2.50
2753	Guaranteed Found	—— ——	10. 9.86	11. 10.24	8. 7.37

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
Swift & Company, Chicago, Ill.	Swift's Pure Early Potato and Vegetable Grower	Kennedy	2107
Swift & Company, Chicago, Ill.	Swift's Pure Fertilizer Superphosphate	New York	2244
Swift & Company, Chicago, Ill.	Swift's Pure Special Potato Fertilizer	Kennedy	2108
Swift & Company, Chicago, Ill.	Swift's Pure Special Potato Fertilizer	Silver Creek	2650
Swift & Company, Chicago, Ill.	Swift's Pure Superphosphate	Randolph	2111
Swift & Company, Chicago, Ill.	Swift's Red Steer	Lounsberry	3010
Swift & Company, Chicago, Ill.	Swift's Special High Grade Acid Phosphate	Union	2541
Swift & Company, Chicago, Ill.	Swift's Special Phosphate and Potash	Horseheads	3022
Swift & Company, Chicago, Ill.	Swift's Special Tobacco Fertilizer	Baldwinsville	2827
Swift & Company, Chicago, Ill.	Swift's Truck Grower	Cortland	2154
Syracuse Rendering Co., Syracuse, N. Y.	Syracuse Animal Brand	Skaneateles	2423
Syracuse Rendering Co., Syracuse, N. Y.	Syracuse Ground Bone	North Collins	2629
Syracuse Rendering Co., Syracuse, N. Y.	Syracuse Market Garden Manure	Baldwinsville	2556
Syracuse Rendering Co., Syracuse, N. Y.	Syracuse Onondaga Brand	Albion	2133
Syracuse Rendering Co., Syracuse, N. Y.	Syracuse Onondaga Brand	Skaneateles	2426
Syracuse Rendering Co., Syracuse, N. Y.	Syracuse Potato Manure	Baldwinsville	2555
Syracuse Rendering Co., Syracuse, N. Y.	Syracuse Special for Celery, Cabbage and Potatoes	Albion	2135

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
2107	Guaranteed Found	3.29 2.76	6. 7.75	7. 8.56	10. 8.44
2244	Guaranteed Found	1.65 1.31	8. 8.22	9. 9.59	2. 2.54
2108	Guaranteed Found	1.65 1.70	8. 7.88	9. 8.33	10. 9.96
2650	Guaranteed Found	1.85 1.46	8. 8.52	8.50 9.47	10. 10.02
2111	Guaranteed Found	1.65 1.24	8. 9.16	9. 9.75	2. 2.34
3010	Guaranteed Found	1.65 1.61	8. 8.36	9. 9.16	2. 2.46
2541	Guaranteed Found	—— ——	16. 15.57	17. 15.79	—— ——
3022	Guaranteed Found	—— ——	10. 10.14	11. 10.89	2. 2.10
2827	Guaranteed Found	—— 4.55	—— 5.27	—— 5.45	—— 11.30
2154	Guaranteed Found	.82 .90	8. 8.51	9. 9.06	4. 4.78
2423	Guaranteed Found	2.46 2.44	8. 8.	9. 9.58	4. 4.54
2629	Guaranteed Found	2.46 2.52	—— ——	23. 24.42	—— ——
2556	Guaranteed Found	3.28 3.22	7. 7.71	8. 8.82	8. 8.22
2133	Guaranteed Found	.82 .87	8. 7.58	9. 8.77	4. 3.94
2426	Guaranteed Found	.82 .82	8. 7.87	9. 8.79	4. 4.12
2555	Guaranteed Found	2.46 2.65	8. 8.72	9. 10.37	6. 5.77
2135	Guaranteed Found	1.24 1.26	7. 6.87	8. 8.47	9. 9.02

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Syracuse Rendering Co., Syracuse, N. Y.	Syracuse Superphosphate	Albion	2134
Thomas & Son Co., I. P., Philadelphia, Pa.	Thomas Long Island Special 4–8–7	East Northport	2214
Thomas & Son Co., I. P., Philadelphia, Pa.	Thomas Truck and Potato Fertilizer	East Northport	2213
Thomas & Son Co., I. P., Philadelphia, Pa.	Thomas Truck and Potato Fertilizer	Riverhead	2382
Thomas & Son Co., I. P., Philadelphia, Pa.	Tip Top Super-Phosphate	Riverhead	2324
Thomas & Son Co., I. P., Philadelphia, Pa.	Truckers' High Grade Guano	Jamesport	2309
Thorburn & Co., J. M., New York, N. Y.	Thorburn's Complete Manure	New York	2250
Thorburn & Co., J. M., New York, N. Y.	Thorburn's Lawn Fertilizer	New York	3051
Tunnell & Co., Inc., F. W., Philadelphia, Pa.	F. W. Tunnell & Co's High Grade Celery, Onion and Lettuce Manure	Chester	2703
Tuscarora Fertilizer Co., Baltimore, Md.	Muriate of Potash	Wayland	3034
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Acid Phosphate	Madrid	2917
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Alkaline	Palmyra	2974
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Big 4 Four	Holley	2461
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Crop Grower	Wayland	3033
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Fruit and Potato	Canton	2902
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora High Grade	Canton	2903

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric Acid. Available.	Phosphoric Acid. Total.	Potash.
2134	Guaranteed Found	.82 .83	7. 7.04	8. 7.84	2. 2.12
2214	Guaranteed Found	3.25 3.03	8. 8.48	——— 9.27	7. 6.83
2213	Guaranteed Found	4. 4.01	7. 8.18	——— 8.63	8. 7.98
2382	Guaranteed Found	4. 4.18	7. 7.49	——— 8.15	8. 8.28
2324	Guaranteed Found	2.50 2.61	8. 8.15	——— 9.35	4. 4.28
2309	Guaranteed Found	3.25 3.11	7. 7.07	——— 7.93	7. 8.22
2250	Guaranteed Found	2.47 2.69	6. 7.27	7. 8.72	6. 5.76
3051	Guaranteed Found	4.94 4.98	8. 8.39	9. 9.43	5. 5.48
2703	Guaranteed Found	2.47 2.43	6. 7.98	8. 8.43	10. 10.22
3034	Guaranteed Found	——— ———	——— ———	——— ———	48. 51.60
2917	Guaranteed Found	——— ———	14. 14.33	——— 14.48	——— ———
2974	Guaranteed Found	——— ———	10. 10.53	——— 11.17	5. 5.14
2461	Guaranteed Found	1.65 1.73	7. 7.09	——— 8.32	4. 4.48
3033	Guaranteed Found	.82 .79	8. 8.56	——— 9.15	2. 2.32
2902	Guaranteed Found	1.65 1.65	8. 8.06	——— 9.16	10. 10.32
2903	Guaranteed Found	——— ———	10. 10.64	——— 10.91	8. 8.16

ANALYSES OF SAMPLES OF FERTILIZERS

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Phosphate and Potash	Port Leyden	2690
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Special Potato Grower	Granville	2884
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Standard	Salem	2882
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora Trucker	Madrid	2916
Tuscarora Fertilizer Co., Baltimore, Md.	Tuscarora York State Special	Salem	2881
Tygert & Co., J. E., Philadelphia, Pa.	Tygert's Cabbage Manure	Aquebogue	2348
Tygert & Co., J. E., Philadelphia, Pa.	Tygert's Special Potato and Tobacco Fertilizer	Aquebogue	2301
The Van Iderstine Co., Long Island City, N. Y.	Van Iderstine's Pure Ground Bone	Long Island City	3065
Vaughan's Seed Store, New York, N. Y.	Vaughan's Lawn and Garden	New York	2249
Vaughan's Seed Store, New York, N. Y.	Vaughan's Rams Head Brand Pulverized Sheep Manure	Syracuse	2561
Vaughan's Seed Store, New York, N. Y.	Vaughan's Rose Grower Bone Meal	New York	2248
Weeber & Don, New York, N. Y.	Weeber & Don's Lawn Invigorator	New York	3061
Werner Extract Co., Mechanicville, N. Y.	Werner's Natural Fertilizer	Mechanicville	3127
Whann Co., W. E., William Penn., Pa.	Whann's Chester Valley Cabbage and Cauliflower Manure	Huntington	2204
Whann Co., W. E., William Penn, Pa.	Whann's Chester Valley Special Potato and Truck Fertilizer	Huntington	2205
White's Rendering Works, Poughkeepsie, N. Y.	Pure Meat and Bone Fertilizer	Arlington	3120

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total.	Potash.
		Pounds in 100 Pounds of Fertilizer.			
2690	Guaranteed Found	——— ———	10. 10.49	——— 10.96	2. 1.88
2884	Guaranteed Found	3.30 2.86	8. 8.62	——— 9.02	7. 7.26
2882	Guaranteed Found	1.65 1.64	8. 8.26	——— 9.47	2. 2.54
2916	Guaranteed Found	4.11 4.02	8. 8.47	——— 9.58	7. 7.38
2881	Guaranteed Found	.82 1.05	8. 8.29	——— 9.24	4. 4.04
2348	Guaranteed Found	2.47 2.69	7. 7.26	8. 8.13	5. 5.56
2301	Guaranteed Found	3.29 3.27	6. 6.74	7. 7.77	8. 8.48
3065	Guaranteed Found	2. 2.32	——— ———	27. 28.25	——— ———
2249	Guaranteed Found	2.88 3.32	8. 8.64	——— 11.55	4. 4.18
2561	Guaranteed Found	2. 2.20	1. .95	1.20 1.45	1. 2.40
2248	Guaranteed Found	3.70 4.31	——— ———	22. 22.43	——— ———
3061	Guaranteed Found	2.47 2.23	——— ———	3.50 3.57	2.50 2.40
3127	Guaranteed Found	.05 .04	.01 .11	——— .23	.02 .06
2204	Guaranteed Found	4.11 4.15	6. 6.68	7. 7.82	5. 6.06
2205	Guaranteed Found	2.47 2.63	7. 7.45	8. 8.02	7. 6.94
3120	Guaranteed Found	4. 5.47	——— ———	17 14.50	——— ———

ANALYSES OF SAMPLES OF FERTILIZERS

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.
The Wilcox Fertilizer Co., Mystic, Conn.	Acid Phosphate	Greenport	2370
The Wilcox Fertilizer Co., Mystic, Conn.	Kainit	Greenport	2369
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox Cauliflower Fertilizer	Greenport	2384
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox Dry Ground Acidulated Fish	Greenport	2386
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox 5–8–7 Fertilizer	Greenport	2366
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox Fish and Potash	Riverhead	2381
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox Fish Guano	Greenport	2387
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox Long Island Dry Ground Fish	Aquebogue	2376
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox Nitrate of Soda	Greenport	2368
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox Potato, Onion and Vegetable Phosphate	Greenport	2367
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox Pure Ground Bone	Greenport	2371
The Wilcox Fertilizer Co., Mystic, Conn.	Wilcox 6–8–5 Fertilizer	Greenport	2385
Witbeck, Chas. W., Schenectady, N. Y.	Witbeck's High Grade Lawn Fertilizer	Schenectady	2893
Unknown	Machine Dried Fish Scrap	Riverhead	2339
Unknown	Muriate of Potash	Riverhead	2338

COLLECTED IN NEW YORK STATE IN 1912.

Number.		Pounds in 100 Pounds of Fertilizer.			
		Nitrogen.	Phosphoric Acid. Available.	Phosphoric Acid. Total.	Potash.
2370	Guaranteed Found	—— ——	15.50 15.20	16. 16.37	—— ——
2369	Guaranteed Found	—— ——	—— ——	—— ——	12. 13.
2384	Guaranteed Found	4.11 4.53	6. 6.69	7. 8.99	5. 5.32
2386	Guaranteed Found	7.81 8.57	4. 5.57	5. 6.32	—— ——
2366	Guaranteed Found	4.11 4.64	8. 7.99	9. 9.48	7. 7.14
2381	Guaranteed Found	2.46 2.91	5. 5.25	6. 7.60	3. 4.08
2387	Guaranteed Found	4.10 4.37	2. 2.48	3. 6.63	—— ——
2376	Guaranteed Found	7.50 8.46	4. 5.20	5. 6.19	—— ——
2368	Guaranteed Found	15. 15.41	—— ——	—— ——	—— ——
2367	Guaranteed Found	3.30 3.55	8. 8.66	9. 9.73	7. 7.98
2371	Guaranteed Found	2.46 4.35	—— ——	22. 21.98	—— ——
2385	Guaranteed Found	4.93 5.33	8. 8.01	9. 9.58	5. 5.84
2893	Guaranteed Found	—— 1.97	—— 8.33	—— 10.38	—— 3.12
2339	Guaranteed Found	—— 9.39	—— ——	—— 6.12	—— ——
2338	Guaranteed Found	—— ——	—— ——	—— ——	—— 51.

ANALYSES OF SAMPLES OF AGRICULTURAL LIME

NAME AND ADDRESS OF MANUFACTURER OR JOBBER.	Brand or trade name.	Locality where sample was taken.	Number.		Calcium oxide. Per ct.
American Lime & Stone Co., Tyrone, Pa.	"Burnt Lime for Agricultural Use"	Elmira	3012	G* F	84. 79.69
American Lime & Stone Co., Tyrone, Pa.	Hydra-Oxide of Lime	Elmira	3011	G* F	66.75 71.26
Buffalo Fertilizer Co., Buffalo, N. Y.	Buffalo Brand Agricultural Lime	Moravia	2516	G* F	50. 45.76
Buffalo Fertilizer Co., Buffalo, N. Y.	Buffalo Brand Agricultural Lime	Iroquois	2635	G* F	50. 49.88
The Caledonia Chemical Co., Caledonia, N. Y.	Agricultural Lime	Caledonia	3165	G* F	50. 49.49
The Caledonia Marl Co., Caledonia, N. Y.	Agricultural Lime	Unadilla	2593	G* F	50. 50.60
Conley Stone Co., F. E., Utica, N. Y.	Raw Ground Lime	Chenango F'ks	2440	G* F	51.5 51.52
Corson, G. & W. H., Plymouth Meeting, Pa.	Corson's Prepared Lime Hydrated	Owego	2848	G* F	48. 44.64
Dutchess County Lime Co., Dover Plains, N.Y.	Agricultural Lime	Bedford Hills	3105	G* F	—— 43.75
Edison Portland Cement Co., New Village, N. J.	Limestone	Cortland	3040	G* F	—— 51.32
Genesee Lime Co., Honeoye Falls, N. Y.	Genesee Hydrate	Newfane	2602	G* F	65. 70.34
Genesee Lime Co., Honeoye Falls, N. Y.	Genesee Hydrate	Honeoye Falls	3166	G* F	65. 71.42
The Haserot Canneries Co., Cleveland, O.	Horse Head Carbonate of Lime	Eden Center	2621	G* F	52.56 48.16
The Kelley Island Lime & Transport Co., Cleveland, O.	Ground Limestone for Agricultural Purposes	Perry	2997	G* F	—— 43.19
Le Roy Lime Works and Stone Quarries, Le Roy, N. Y.	Le Roy Agricultural Lime	Le Roy	3164	G* F	—— 68.76
National Mortar and Supply Co., Pittsburg, Pa.	Banner Hydrated Lime	Cherry Creek	2957	G* F	—— 51.12

*G and F mean, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF AGRICULTURAL LIME

Name and Address of Manufacturer or Jobber.	Brand or trade name.	Locality where sample was taken.	Number.		Calcium oxide. Per ct.
New Castle Portland Cement Co., New Castle, Pa.	Pulverized Limestone	Mayville	2961	G*	———
				F	43.50
Rockland & Rockport Lime Co., Rockland, Me.	R-R Land Lime	Jamesport		G*	55.
				F	63.60
Security Cement and Lime Co., Berkeley, W. Va.	Berkeley Hydrated Lime	Clarence	2776	G*	70.
				F	71.48
Security Cement and Lime Co., Berkeley, W. Va.	Ground Limestone	Hamburg	2624	G*	44.
				F	48.74
The Solvay Process Co., Syracuse, N. Y.	Land Lime	Schoharie	2736	G*	60.
				F	69.78
The Standard Lime & Stone Co., Baltimore, Md.	Standard Ground Limestone	Perry	2996	G*	53.
				F	63.48
Woodville Lime & Cement Co., Toledo, O.	Agricultural Lime	East Aurora	3153	G*	———
				F	50.68

* G and F mean, respectively, Guaranteed and Found.

ANALYSES OF SAMPLES OF LIME COMPOUNDS

Name and address of manufacturer or jobber and brand or trade name.	Where taken.	Number.		Phosphoric Acid		Potash.	Calcium oxide.
				Available.	Total.		
The Caledonia Chemical Co., Caledonia, N. Y. Wood Ashes Substitute	East Schodack	3124	G*	1.50	2.50	5.50	35.
			F	1.40	1.73	5.44	42.56
Corson, G. & W. H., Plymouth Meeting, Pa. Corson's Prepared Lime and Ash	Apalachin	2810	G*	—	—	3.	40.
			F	—	—	2.92	31.52
New England Lime Co., Danbury, Conn. Connecticut Lime Ashes	Oneonta	2841	G*	—	—	—	—
			F	—	1.12	1.42	29.98

* G and F mean, respectively, Guaranteed and Found.

APPENDIX.

I. Popular Editions of Station Bulletins.

II. Periodicals Received by the Station.

III. Meteorological Records.

POPULAR BULLETIN REPRINTS.

A NEW FRUIT TREE ENEMY IN NEW YORK.*

F. H. HALL.

Advent of pear thrips. A recent surprise to entomologists is the finding of pear thrips in New York State. This insect has been present in California in destructive numbers for several years, but was unknown in the East until in the spring of 1911. Before this time, for a period extending back at least five years, it had been at work, unrecognized, in a limited section of the Hudson Valley — in about three townships in the vicinity of Germantown; but the pear growers whose orchards were infested, in some cases to a very injurious extent, had thought the damage due to frost, spray injury or other causes. The few who had seen the insects on the buds or in the blossoms could not believe these tiny creatures the cause of such severe injury as occurred in some of the orchards; but investigations made by the Station Entomologist during 1911 have proved the trouble due to the insect and have established its identity with the pear thrips *(Euthrips pyri)* which is causing California fruit growers so much harm.

Extent of infestation. Beside the three townships on the east side of the Hudson, in Columbia and Dutchess counties, the insect is apparently present in a few orchards further down the Hudson, on the opposite side of the river, and in at least one orchard in western New York. Further study will probably show that it is much more widely distributed than is now known; since it is easily overlooked when not abundant, and its work ascribed to other causes even when it is numerous and destructive.

* A reprint of "Popular Edition" of Bulletin No. 343; see p. 341 for the Bulletin.

Amount of injury. In 1910, when the loss from the thrips was greatest, pear growers in the region about Germantown found their Kieffer crops reduced from one-third to nine-tenths or even more. The excessive damage during this season was probably due to the early and sudden arrival of warm weather which favored the insects and also brought the pears into bud and bloom when the pests were most abundant. The union of these two factors exposed practically all Kieffers and some other varieties to the attacks of countless hordes of the thrips at the most critical time. In 1911, the damage to Kieffers, though general in some orchards and severe in scattered spots in other orchards, was not nearly as great as in 1910; while Bartletts and Clapp Favorites, the other varieties most grown in the section, were not seriously injured. Beurre Bosc, Beurre Anjou, Vermont Beauty, Dana Hovey, Rhode Island, Clairgeau and Beauty of Wakefield were badly affected; but these varieties are not generally grown so the loss on them was not great.

Adult insect. The mature thrips is a very minute insect, only one-twentieth of an inch long. It is dark brown in color, appearing almost black on casual view; and bears four peculiar, long, narrow, feathery wings which gave the thrips its old name, "fringe-wings." The wings are simple and each consists merely of a single strong rib bordered by closely set, long hairs.

These adults come from resting cells in the soil, where they have spent the winter. The date of emergence varies with the season, but is apparently timed to precede by a few days the swelling and opening of the pear buds. Growers, where the insect is suspected or where pear buds have blighted from unknown causes, should watch their trees carefully from the middle of April on, and if they find them spotted with tiny dark flies, should prepare for immediate, vigorous action.

In 1911 the adults were most active and destructive from April 28 to May 11. As soon as they come from the ground they seek the trees whose buds are nearest ready to open, and work their way between the spreading tips into the centers of

the young flowers. They rasp and puncture the tender parts at the center of the bud and suck up the exuding juice for food. These injuries, it will be seen, strike at the very heart of the hoped-for crop and result in more harm than might be caused later by many times the number of larger insects. Yet the numbers of the thrips, even at this stage, are by no means small; and two weeks later the white, maggot-like larvæ may be found clustered about the buds or in the open flowers like mites upon fowls in a neglected poultry house, as is shown by the title page illustration. The early injuries by the adult thrips, when these are numerous, cause the buds to become "leaky," that is, sticky with a viscid, brownish secretion — a condition very characteristic of the work of this insect. At this time most of the adults are beyond the reach of spray mixtures, but preparations should be made to attack the larvæ as soon as the falling of the petals makes it safe to spray the flowers.

The injured buds cease to grow and the whole blossom cluster, if the mature thrips are plentiful, becomes stunted, shrivelled and brown, as if blighted. If the attack is not made quite so early, the insects feed in the opening blossoms, eating stamens, pistils and petals; or they may attack the tender leaves as these appear. On the clusters attacked, the petals will be small and uneven in size, the fruit stems dwarfed and irregular in length and the flower generally blackish or brownish in color. The leaves of the first-formed clusters are usually dwarfed in size, crinkly, cup-shaped or otherwise deformed, and with margins irregularly broken or blackened. The fruits setting on such clusters generally have weak stems and fall prematurely.

Egg-laying. The microscopic, whitish or yellowish, kidney-shaped egg is placed within the tissues of the plant. The female generally selects the fruit stems for egg-laying and slits them with her sharp, curved ovipositor, depositing a single egg in each slit. She begins this work soon after emerging from the ground and continues it until about the middle of May. The incisions may sometimes be so frequent in a single stem that it will become weak and yellow, allowing the fruit to fall prematurely. Usually the stems are only roughened.

Larva. The eggs hatch within a week after laying, and produce small, white, soft-bodied larvæ with two pronounced reddish eye spots. These larvæ are provided with mouth parts like those of the adult, but are somewhat less active and destructive. On the pear they feed mainly on the young leaves and emphasize the injury done by the adults, since they are naturally most abundant on trees that have fed the parent insects in largest numbers. This additional shock to the tree greatly retards its return to a normal condition, as the leaves are often destroyed or deformed to such an extent that the young pears that have set cannot be nourished and, therefore, drop; nor can new fruit spurs for the next year be developed. Later, the larvæ feed to some extent on the tips and edges of the growing terminal leaves, which may be blackened. A secretion similar to that produced on the buds by the adult thrips may also be caused by the work of the larvæ.

After feeding for about two weeks the larvæ drop from the trees, may feed for a time on weeds and grass, and then enter the soil to form the resting cells. They remain unchanged in these until late October, then change to pupæ and pass the winter in that stage or as hibernating adults.

Food plants. While commonly called "pear" thrips, this pest may feed or work on quite a range of plants. It was found in New York during 1911 on apple, apricot, cherry, peach, plum and quince as well as on pear; and in California it also attacks almond, fig, grape and English walnut. If it becomes established in the East it may have to be fought on the above fruits and probably others.

Control. As a sucking insect, the thrips cannot be reached by internal poisons, but must be destroyed by contact insecticides. It is not difficult to kill, if reached, as the spraying experiments of 1911 proved that it would be destroyed by a good wetting with any of the insecticides used. The difficulty is, however, that the adults very soon get into the buds where spray mixtures cannot reach them directly. Early recognition of their presence and prompt, thorough, quickly repeated applications are necessary for success.

The nicotine preparations are very effective, especially when combined with an oil emulsion which has a penetrating quality. In 1911 three sprayings in a badly infested orchard, two applications on successive days and the third one two days later, reduced the numbers of thrips to a very small proportion of those originally present. In these treatments, the nicotine preparations, Black Leaf and Black Leaf 40, were used alone and each combined with soap or with kerosene emulsion; and there seemed to be little difference in effectiveness. Each mixture destroyed the insects it touched. Conditions were particularly favorable for treatment this year, however, since the buds opened very rapidly, allowing the spray mixtures to be forced into them more readily than might be the case in cooler weather when the trees bloomed more slowly. The thrips also probably came out within a shorter period than in cooler years; so that more of them were caught by the three sprayings than would be when the emergence was longer distributed. It is hoped, though, that two or at most three thorough applications of nicotine and kerosene emulsion made at short intervals with a heavy, driving spray, using 125-150 lbs. pressure, when the mature insects are seeking the buds, will reduce them to a comparatively harmless number.

Formulas.

Spraying mixtures.

1.

Nicotine extract 2.7 per ct. (Black Leaf)	6 qts.
Water	100 gals.
Soap	2 to 5 lbs.
or	
Kerosene emulsion	3 gals.

2.

Nicotine extract 40 per ct. (Black Leaf 40)	½ to ¾ pt.
Water	100 gals.
Soap	2 to 5 lbs.
or	
Kerosene emulsion	3 gals.

Directions for spraying.

In spraying, two objects should be kept in mind — (1) to kill the winged thrips working in and about expanding buds and blossom clusters to prevent injury to the tender flower and leaf parts;

and (2) to destroy the larvæ after petals drop to reduce the numbers of insects which will mature in the ground.

The period for effective spraying against the adult or winged thrips is during the time when the buds are swollen and partly open and until they are entirely opened at the tips. The first treatment should be made as soon as the thrips become numerous on the trees. The number of the applications required will depend on the thoroughness of the treatments. The grower should spray on successive days or every few days until the thrips are reduced to comparatively few individuals. Two and certainly not more than three sprayings are required to afford efficient protection to the trees from the adult thrips. Especially hard to kill are the insects within the buds, as they are often hidden, and it is difficult to force the spraying mixture in between the growing structures of the bud. While it is not possible to reach all of these, many of them may be destroyed by careful work in applying the sprays. By successive applications severe injury may be largely or entirely prevented. To secure the greatest benefits from the treatments, apply the spraying mixtures in liberal quantities as a rather coarse driving spray, holding the nozzle fairly close to the buds in order to force the liquid into the ends of the buds. The "angle nozzles" of the large chamber type or nozzles set on an angle to the extension rod, maintaining a pressure of not less than one hundred fifty pounds are preferable.

The larvæ may be seen in large numbers as small, whitish creatures in the calyx cups, on pears especially (see title page illustration), when they are well exposed to spraying because of the open nature of the blossom ends of the young fruits. One or two careful sprayings will practically free the trees of the insects. In making an application both surfaces of the leaves and the calyx ends of the young fruits should be thoroughly wetted by the liquid. Spraying for the larvæ is important because it will greatly reduce the numbers of the insects which seek shelter in the ground until the following spring.

(Plate XXXV was also given in this popular edition.)

FIGHTING LEAF-HOPPERS IN THE VINEYARD.*

F. H. HALL.

Increase of the insect.

The grape leaf-hopper, or "thrips" is by no means a new insect; but its numbers are sometimes so small and its injuries so inconspicuous that its presence in the vineyard is disregarded. Occasionally there comes a year, however, or a series of years, when the tiny creatures become so numerous as to fill the air at picking time, thus greatly annoying the vineyard workers. At such times, also, the student of grape quality notes a greatly increased proportion of poorly colored, insipid flavored or sour grapes; and, sometimes, as in 1910 and 1911 and even more noticeably in 1901 and 1902, in the Chautauqua and Erie grape belt the quantity of grapes in many vineyards is decidedly lessened by the countless hordes of these minute pests. During 1910 and 1911 those growers having infested vineyards who protected their vines against the "hoppers" secured a profitable crop increase, to say nothing of the fact that their fruit was not rejected because of poor quality by the makers of grape juice, and was in better condition for the packing of basket fruit for dessert use. For several seasons the pest has been increasing in Chautauqua county; but whether 1911 marked the crest of the wave or whether a worse infestation is to come in 1912, no one can say. The countless millions of the mature hoppers that went into winter quarters last fall certainly promise trouble for the growers this summer unless weather conditions or other influences reduce their numbers before grape foliage appears.

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* A reprint of "Popular Edition" of Bulletin No. 344; see p. 367 for the Bulletin.

The insect.

The grape leaf-hopper is about one-eighth of an inch long, light yellow during the summer, but changing to salmon color toward fall and becoming dark red in its winter hiding place. One of the adults is shown on page 819 and five nymphal stages or "instars" in the adjoining figures. These differ from each other mainly in the increasing prominence of the wing pads; since the hoppers do not pass through larval, pupal and adult forms which differs so markedly in most insects. The adult hoppers have a front, or outer, pair of wing shields, or "elytra", which close along the back, making a tight, tent-like cover beneath which the thin, filmy, true wings are concealed when the insects are not in flight.

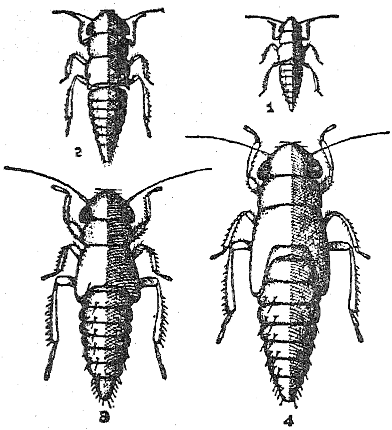


FIG. 1—FIRST FOUR NYMPHAL INSTARS OF GRAPE LEAF-HOPPER. (Enlarged.)

The protection given the little pests by these resistant wing covers makes it very difficult to injure the adults by spraying, since the ordinary mist spray does not reach any tender part of the body. Both old and young "thrips" are still further protected by their habit of feeding on the under side of the leaves, so that, to combat them successfully, driving sprays must be used that catch them from below and drench them thoroughly.

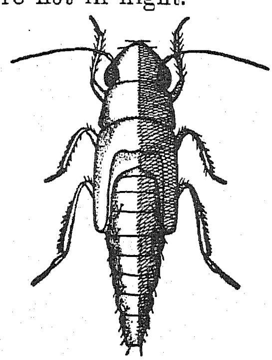


FIG. 2—FIFTH NYMPHAL INSTAR OF GRAPE LEAF-HOPPER. (Enlarged.)

Time of feeding.

The adult hoppers winter in protected places about the vineyards, weeds, piles of rubbish, ditch banks or other neglected corners of the vineyards themselves or woodland, undergrowth or grass lands adjoining them. They appear before the grape foliage has started and feed for a time on early spring weeds or other

perennial plants, preferring the foliage of bush fruits. As soon as the grape leaves appear they migrate to the vines and feed on them until fall. They will be noticed first on shoots and leaves near the ground, but later on all parts of the plants.

They mate during the latter part of May and the eggs are laid during the month of June. The first nymphs appear about the middle of June and the maximum number is out by the end of the first week in July in normal seasons. A second partial or complete brood appears the latter part of August if conditions are favorable. By the time the grape leaves have fallen most of the insects are mature and seek protected hibernating places.

How the hoppers work.

The grape leaf-hopper feeds by sucking, and, preferably, on the under side of the leaves. It pierces the "skin" of the leaf, feeds until satisfied and then withdraws its proboscis or sucking tube thus leaving an opening from which the plant juices dry out, not only from the pierced cell, but from adjoining ones. There is soon formed around each puncture a spot of dead tissue; and if there be 100 hoppers on a leaf, each feeding twice a day for two months, the leaf would show 12,000 such injured spots. In fact, counts have been made on leaves of average size that gave 20,000 spots. This makes a severe drain on the vitality of the leaf and it takes on an unhealthy yellow hue. The death of so many starch-making cells lessens the amount of wood produced and of fruit formed; and, more disastrously perhaps, it affects the quality of the fruit, making it ill flavored or sour and poorly colored. The rich blue black of the Concord becomes a lifeless reddish color when hoppers are abundant and the attractive flavor is lost so that grape juice makers and most buyers of grapes for the table reject the fruit.

Control measures.

As the leaf-hoppers feed by sucking, they cannot be poisoned; but must be killed by contact insecticides. In tests made during 1910, it was found that the nicotine preparations were very effective if properly applied. But the protection given by the manner of feeding beneath the leaves made it almost impossible to reach

them effectively with any sprayer fitted with *fixed* nozzles. Hand management of the nozzles, with free hose, gave better results, but is a more expensive method, and, with nicotine, exceedingly unpleasant, drenching of the clothes by the wind causing nausea and illness in many cases.

The method of applying then, rather than the material to be used, appeared most needful of study; therefore the efforts of the Station entomologist in the Chautauqua field were directed toward the development of an attachment for power spray outfits that would put the material where needed without personal discomfort.

A device of this kind had been made in 1911 by Mr. F. A. Morehouse, of Ripley; but was not a success because of certain defects. After considerable study this attachment was so modified that it gave most excellent results in actual field work.

Automatic spraying attachment.

This attachment consists of an iron pipe framework attached rigidly to the side of the spray cart, which carries three movable booms at different heights, each swung out under the vines by a coiled-wire spring and fitted with hose-and-pipe connection leading to an adjustable nozzle at the end. The springs are made strong enough to hold the nozzles in position under or among the leaves against ordinary resistance but allow the booms to swing past fixed obstructions. The nozzles are protected against entanglement with vines or foliage by inclined guards. The range in height given by the three booms, with a difference in their length, and the change in direction of the spray allowed by the adjustable nozzles make it possible to cover thoroughly all parts of the vines.

No attempt is made here to give details of this attachment; but a full description of it is given in the regular bulletin, with plans and illustrations. It can be constructed by any blacksmith or plumber for less than $20.

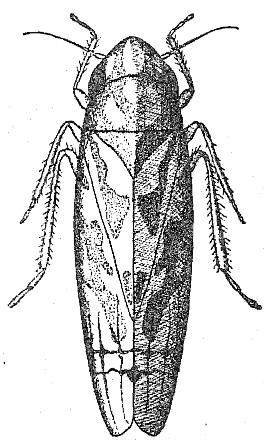
Directions for spraying.

Spraying should be done when the nymphs (young "hoppers") have reached their maximum numbers, which, in Chautauqua county, will be some time in July, the exact period varying somewhat with the season.

Efficient and economical nicotine sprays are "Black Leaf Tobacco Extract" (2.7 per ct. nicotine), one part to 150 parts of water, or "Black Leaf 40" (40 per ct. nicotine), one part to 1600 parts of water. Enough of this spray must be used to drench the insects, an amount best secured by using nozzles of the cyclone type with large-apertured disks with a pressure of 125 to 150 lbs. at the pump. The nozzles must be adjusted to hit the under side of the leaves, the lower one usually being set to throw the spray directly upward and the other two varied to suit conditions. It will be necessary to drive slowly if the foliage is dense; so that gearing must be provided that will maintain the required pressure even when the outfit is moving at low speed.

With such a sprayer it will require about 150 gallons of solution to spray an acre of vines with dense foliage; for which the materials will cost about $1.25.

(Plate XXXVII was also printed in this popular edition.)



QUALITY OF FARM SEEDS IN 1911.*

F. H. HALL.

Seed inspection needed.

That an official inspection of seeds could be made very helpful to New York farmers is shown by examinations made by the Station during 1911. These tests are made by the Station botanists from samples of seed sent in voluntarily by dealers and purchasers. Such work does not have the range nor the accuracy of official collection and analysis; yet the samples examined probably reflect quite accurately the general condition of clover and grass seeds sold in the State during the year.

Dodder seeds were found in one-eighth of the samples of alfalfa seed examined, and in nearly 5 per ct. of those of red clover; yet dodder is perhaps most to be dreaded of all the weeds that infest these crops. Red clover and alsike clover both contained more seeds of noxious weeds than in 1910. Wilful adulteration of seeds was somewhat rare; yet one sample of red clover contained only 5 per ct. of the desired seed, 35 per ct. being alsike clover and 60 per ct. yellow trefoil. In this case about four quarts of the trefoil seed had been introduced into the middle of each bag of clover seed and the sample was evidently taken from near the center of the bag so that much of the adulterant was secured. If it had been taken from the top of the bag only, the seed might have shown up well. This illustrates the necessity of drawing some of the sample from different parts of the bag if dependable results are to be secured. Accidental adulteration is not uncommon, for yellow trefoil and sweet clover have become so plentiful in many clover and alfalfa fields that the seeds of these weeds were found in considerable quantity in many samples.

Notes on tests.

During the year 1911, the Station examined 1015 samples, about 70 more than in 1910. Of these samples, 548 were of alfalfa, 253 of red clover, 86 of alsike clover, 98 of timothy and 30 of miscellaneous seeds. Many of the samples were too small to give dependable tests. The likelihood that a sample represents fairly the goods from which it is drawn decreases rapidly as the sample falls below certain limits. In official test-

* A reprint of "Popular Edition" of Bulletin No. 345; see p. 179 for the Bulletin.

ing, seeds are secured from top, middle and bottom of the bag or other container, and from these lots, thoroughly mixed, at least two ounces are retained for final examination if the seed is of alfalfa or clover, or at least one ounce if of timothy or other grasses. These figures should govern in unofficial sampling, also; but of the alfalfa and clover seed samples received by the Station during 1911, only a little more than one-third were up to the weight required for dependable analysis; and of the timothy seed samples less than one-half reached one ounce in weight. In nearly 200 cases the sample sent weighed less than half an ounce. Such small samples may give some information, but they are not satisfactory for accurate percentage determinations.

Weed seeds found. Some seeds of new weeds were found, the presence of these seeds indicating, in general, that the sample of alfalfa, clover or timothy came from a foreign source, although some weeds may be recent introductions into America.

One of these weeds, *Trianthema monogyna,* is a "pusley"-like plant, quite common in the West Indies, and found sparingly in some of the Southern States. It has certainly been sown with alfalfa seed in this State, as it was found in 26 samples; but no plant of it has been sent in for identification, so it can not be well established, nor do we know anything of its behavior under our conditions. Shaftal is another plant of which seeds were found in small quantities in 16 samples of alfalfa seed. This belongs to the clover family, is an annual, and is not liable to become a troublesome weed, although a vigorous grower. Lance-leaved sage, found in 10 samples of alfalfa seed, is another annual, and probably not to be feared as a weed.

Other noteworthy weeds found in the examinations of this year have been Russian thistle, roquette and Johnson grass. The first of these is a serious menace in parts of the West, but in New York alfalfa fields it disappears after the first season, so can not be considered a bad weed. Roquette, a plant of the mustard family, makes a rank growth in alfalfa, and has been the cause of much anxiety to growers; but, like Russian thistle, it is in evidence only during the first season and is evidently not to be feared. In the South, Johnson grass, a species of sorghum, is troublesome. How it will behave in this State is unknown, but it may become established here through its occurrence in alfalfa seed. Any information relative to the presence or behavior of the plant in New York will be welcomed by the Station.

The principal impurities found in the seed examinations are shown in the table below:

PRINCIPAL IMPURITIES FOUND IN SEEDS EXAMINED IN 1911.

	Number of Samples			
	Alfalfa	Red clover	Alsike clover	Timothy
Examined	548	253	86	98
CHARACTER OF IMPURITY FOUND:				
ADULTERANTS:[1]				
Alsike clover	....	2	....	1
Catchfly	....	....	1	....
Red clover	....	....	1	....
Sorrel	....	....	1	....
Timothy	....	....	5	....
White clover	....	....	1	....
Trefoil	....	1	4	....
NOXIOUS OR NEW WEEDS:				
Canada thistle	....	16	29	3
Centaurea repens	52	....	....	....
Chicory	66	6	....	....
Dock	65	147	38	....
Dodder	71	....	....	....
Johnson grass	26	....	....	....
Lance-leaved sage	10	....	....	....
Plantain, English	88	163	27	12
Roquette	33	....	....	....
Russian thistle	171	....	....	....
Shaftal	16	....	....	....
Trianthema monogyna	26	....	....	....
Wild carrot	33	20	2	....

	Number of Samples			
	Alfalfa	Red clover	Alsike clover	Timothy
COMMON WEEDS, GRASSES, ETC.				
Alsike clover	14	106	....	71
Atriplex spp	76	....	....	....
Barnyard grass	9	....	....	....
Brassica spp	76	12	....	2
Catchfly	20	52	37	7
Chickweed	....	....	....	6
Cinquefoil	....	....	....	28
Crab-grass	....	24	....	4
Daisy, ox-eye	....	....	5	3
Daisy, yellow	....	....	....	21
Foxtail, green	377	148	22	....
Foxtail, yellow	161	27	....	....
Lady's thumb	....	65	1	....
Lamb's quarters	225	95	17	40
Mallow	50	....	....	....
Mayweed	....	....	....	6
Melilot	51	....	....	....
Pepper grass	....	....	....	41
Pig weed	....	24	3	....
Plantain, broad	....	....	12	65
Primrose, evening	....	....	....	37
Ragweed	....	73	....	....
Sorrel	....	96	50	30
Sweet clover	91	....	....	....
Timothy	49	101	63	....
Trefoil	5	20	60	....
White clover	....	....	....	5

[1] An impurity is considered an adulterant when it exceeds a certain fixed percentage of the sam ple.

Sulphured oats.

Several samples of oats were received with special requests for germination tests, as growers who had sown seed from lots represented by these samples found that only a few seeds grew.

The unusually light-colored, bright, smooth, vigorous appearance of the samples of seed led to the suspicion that it had been treated with sulphur fumes, a bleaching agent; and examination made in the Chemical Laboratory of the Station proved sulphuric acid present in injurious amounts. Germination tests made of four samples showed fourteen per ct. of live seed in one sample, one per ct. in the second sample and all seeds dead in two samples.

Bleaching, if properly done, probably does not injure oats for feeding and may not reduce the viability; but particularly bright looking seed should be given a germination test before using.

CROSSING TOMATOES TO INCREASE THE YIELD.*

F. H. HALL

"New blood gives new vigor."

Stock breeders have long recognized the principle that mating animals of different strains, races or varieties of the same or closely allied species usually gives offspring of great vigor and frequently of larger size than the parents. This view had received some recognition from scientists even before the time of Darwin; but he collected so many illustrations of its truth among both animals and plants that biologists generally accepted the principle as one of Nature's laws, though it is a law with exceptions. Other students and investigators since Darwin's time have tested this law in many fields, and among others, have proven it true with corn, beans, sorghum, cotton, tobacco, peas and other farm crops.

Test on tomatoes.

From some previous work in Michigan, Prof. Hedrick, Horticulturist of this Station, believed this same law would apply to tomatoes and suggested to Mr. Wellington, his assistant, that he investigate this question. The results of these tests are here summarized: As parents two varieties of tomatoes were selected that were greatly alike in respect to color, form and size of fruit and foliage, but decidedly unlike in plant habit, one being a dwarf — Dwarf Aristocrat, and one a standard — Livingston Stone. These varieties were grown in the forcing house during the winter of 1907–8 and carefully crossed, using the dwarf variety as the female parent and the standard variety as the pollen producer. On other plants of each variety, flowers were also bagged before opening, to insure pure seed of each for comparison. One hun-

* This is a brief review of Bulletin No. 346 of this Station on the Influence of Crossing in Increasing the Yield of the Tomato, by Richard Wellington. Any one interested in the details of the investigation will be supplied, on application, with a copy of the complete bulletin. Names of those who so request will be placed on the Station mailing list to receive future bulletins as issued, popular or complete edition as desired.

A reprint of "Popular Edition" of Bulletin No. 346; see p. 423 for the Bulletin.

dred plants of each kind were set in the field in the summer of 1908 under as uniform conditions as possible and all but one went through the season, one of the cross-bred plants being destroyed accidentally. All the cross-bred plants were standards, as was expected from the laws of heredity. Seed of each of these strains of tomatoes was secured from self-pollinated flowers; and from this seed plants were grown for the winter forcing-house test of 1908–9. No first-cross plants were used in this test, but the parents were compared with their pure descendants of the second generation. In accordance with the laws of inheritance, plants of the second generation included both standards and dwarfs, but only the standards were used, the dwarfs being "rogued-out." For the test of the next summer, crossed plants of the first generation were used as well as plants from pure seed of the parents and of the first and second generations; so that the parents and three generations of descendants were compared. In 1910 fourth-generation plants were also grown with the others. In every case dwarf plants were left out of the tests, although some appeared in every generation except the first.

Results. In all the tests the plants were given as uniform conditions as possible and enough of each kind were included to overcome individual variations. They were, of course, subject to drought and other unfavorable influences that affected other tomato fields in the locality, but gave fair yields for the season in each test. It is believed that the influence of the disturbing factors was so evenly distributed that the figures really show the differences due to effects of crossing. The data appear in the table on page 4.

In each of the field tests the crossed plants of the first generation gave both more ripe fruit and a larger total yield than the standard parent. The average gain in ripe fruit was nearly two pounds per plant and in total yield more than three pounds per plant. On the basis of 2,722 plants to the acre (plants set 4 ft. x 4 ft.) this would give nearly 2½ tons more of ripe fruit to the acre or 4½ tons more total yield from the first generation crosses than from the standard parent. This would certainly be a profitable return for the time and care necessary to secure the crossed seed.

It is only in the first generation that this favorable influence is likely to be profitable; for in the second generation, in this case, many plants had to be thrown away because of return to the dwarf condition; and the average yield of ripe fruit was not in-

creased at all. If large numbers of plants had been used, one-fourth of all in the second generation would have been dwarfs, and therefore not usable. Of course, two standard parents might have been used, so that none of the descendants would be dwarfs, but

YIELD OF TOMATOES FROM PARENT VARIETIES AND FROM SEEDLINGS OF FOUR GENERATIONS.

		Dwarf Aristocrat. Dwarf parent.	Livingston Stone. Standard parent.	DWARF ARISTOCRAT X LIVINGSTON STONE.			
				First generation.	Second generation.	Third generation.	Fourth generation.
FORCING HOUSE TEST: (Winter, 1908–'9.)		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Ripe fruit per plant		2.0	3.1	....	3.4	....	....
Total fruit per plant		2.6	4.3	....	4.4	....	....
FIELD TESTS:							
Ripe fruit per plant	1908	8.5	12.3	13.9	....	....	....
	1909	6.1	10.1	12.9	12.0	13.0	....
	1910	7.0	12.0	13.2	10.0	9.8	11.4
Average		7.2	11.5	13.3	11.0	11.4	11.4
Total fruit per plant	1908	14.8	20.9	25.3	....	....	....
	1909	9.7	17.7	20.0	20.0	18.0	....
	1910	14.8	24.7	27.7	25.1	22.8	23.8
Average		13.1	21.1	24.3	22.6	20.4	23.8
Yield per acre (2,722 plants.)	1908	40,163	56,822	68,898	....	....	....
	1909	26,349	48,152	54,500	54,576	48,958	....
	1910	40,234	67,244	75,293	68,439	62,173	64,796
Average		35,882	57,406	66,230	61,508	55,556	64,796
Average gain or loss as compared with Standard parent		—21,524	....	+8,824	*+3,810	*—2,142	†—2,448

* Compared with average yield of standard parent for same two years.
† Compared with yield of standard parent for same year.

unless the parents differed in some striking particulars it is doubtful if the same marked influence from crossing would have been secured. Without this marked difference shown in the early life of the plants it would be impossible to remove the "rogues"; and undesirable unevenness of the tomatoes in some point might

occur to lessen the market value of the crop. Beyond the second generation, the effect of the crossing in this experiment proved to be detrimental.

Why does crossing increase yield?

The fact that crossing parents not too closely nor too distantly related increases the vigor, size and productivity of the offspring is apparently well established; but only recently has any plausible explanation for this effect of cross-breeding been given. Now, however, Mendel's experiments and observations on heredity have given at least a workable theory to account for this increase in size or vigor in the first generation of descendants from parents of diverse characteristics, and the rapid disappearance or reversal of this favorable effect in subsequent generations.

Gregor Mendel worked in a very modest way and announced his results in such an obscure publication that they remained hidden from the scientific world for many years, but when brought to light about fifteen years ago, furnished the long-desired explanation for many of the problems of heredity. He found that certain forms, features or characteristics of plants,—since called "Mendelian characters" or "unit characters"— pass unmodified from ancestor to descendant and therefore remain the same however remote the inheritance. The same law applies to animals, as well. These "Mendelian characters" in many cases are not what we ordinarily consider characteristics, but are biological factors, several of which may be combined to make up what we call an animal or plant characteristic; as number of joints and length of joints, which are unit characters in a plant stem, unite to make up "tallness." All the "unit characters" of both parents must pass into their descendants of the first generation, according to Mendel's laws, though they may not appear to do so. If two characters are opposed, as horn-bearing and hornlessness in two breeds of cattle that are crossed, only one can appear in the immediate progeny of the cross though both are transmitted to and by the individuals of this first generation. The "dominant" or stronger one of the pair obscures or hides the weaker or "recessive" character in this case; but when two individuals of this first generation are mated, or, in plants, when a self-fertilized individual of this first cross produces seeds, the two unit characters separate; so that some individuals of the second generation show the dominant character only, some the recessive character only and these individuals have not received nor can

they transmit to their descendants, the character they do not show. Others still, about half when the number of descendants is large, are like the first generation, containing both unit characters, the "recessive" hidden by the "dominant." These latter animals or plants, showing the "dominant" unit character resemble the pure dominants outwardly in respect to this particular character, but some of their descendants will show the recessive character; which descendants of pure dominants never show. There are, of course, hundreds of such pairs, and many characters not contrasted or balanced by others (technically known as "unpaired genes"), since there are innumerable features and characteristics in each animal or plant each of which may be made up of one or several unit characters. Accordingly, the separate descendants in any generation may be quite unlike through varied groupings of the numerous dominants and recessives, and very careful study is necessary to disentangle the mystery of inheritance; but we know that the law given above holds true for each pair of unit characters.

If two unit characters that make up any feature or characteristic of a plant or animal be not opposed, though different, both may appear in the first generation; so that, with regard to that particular feature, the good or bad points of both male and female parent may come together in the descendant. For example, if a plant with many long joints be crossed with one whose joints are thicker and heavier, the descendants of the first generation may inherit both the length and the thickness, thus making larger, stockier plants than those of either parent.

Similarly, certain different, but not opposed factors that go to make up vigor, healthfulness, or productivity may be united when different strains are crossed; and the descendants, accordingly, give better yields than either parent. In the second generation, with the splitting up of unit characters that takes place, only half the descendants will carry the united characters; and the yield will tend toward a mean between that of the parents and the first generation. With each subsequent generation the proportion of plants bearing these joined favoring factors will decrease and the beneficial influence of the crossing be soon lost.

The figures secured in these tomato experiments support this theory admirably; though we are not able to say what influences united to give the favorable result in the first place. The constitutional "unit characters" that make up vigor, health and productiveness have not yet been separated.

Practical suggestions for seed growing.

The parent plants used in these tests were not specially selected; and better results would undoubtedly have been secured if, for one or two generations previously, high-yielding mother plants had been chosen. This could easily have been done, and the strain kept pure, since tomatoes are readily self-fertilized. These high-yielding strains should be continued and new crosses made as new seed is needed. The crossing need not be done every year, since tomato seed retains its vitality for at least three years, so that enough crossed seed could be secured in one season to grow the crop for three years to follow. But the tomato grower who does not regularly raise his own seed must buy the crossed seed each year unless he wishes to find his second-season crop running down in yield. The improvement in yield is not inherent in the strain; it is merely the result of the crossing.

Too violent crossing must not be attempted else sterility will result, as in the well known case of the mule. In crossing the tomato and Jerusalem cherry at this Station total sterility resulted.

The best results can probably be secured by keeping within the species and crossing the distinct varieties and the distinct strains; and in selecting these, regard must be paid to the inheritance of such qualities as smoothness, color, shape, size and earliness. To obtain smooth fruits only varieties producing smooth, even-surfaced fruits should be used, since roughness appears in the first generation. If dark red tomatoes are desired, one of the parents at least must be dark red; but the other may be red, pink or yellow, since the red is a stronger character than the pink or yellow and will hide them in the first generation. If pink is desired the red must be avoided and two pink varieties or a pink and a yellow used; while to get yellow fruits both parents must be yellow.

Size appears to be inherited in a blended condition, as it is probably not a unit character; therefore to obtain tomatoes of large size, both parents must produce large fruits, to produce small ones both parents must be small-fruited; while to produce medium-sized fruits, either medium-fruited parents must be crossed or small-fruited and large-fruited types. The same condition prevails with regard to general shape as with size,— an intermediate inheritance; and earliness probably follows the same rule.

It is believed that this crossing of tomatoes is an entirely practicable and profitable business proposition since it is not a difficult nor expensive operation. The actual pollination is not so easy as with corn, where the pollen is produced in the tassels, which can easily be removed to prevent self-fertilization; but the tomato produces so many seeds that comparatively few flowers need be pollinated to secure the quantity of seed desired. The blossoms on the female parent must be bagged some time before opening, to prevent undesired crossing, and the stamens removed two or three days before the pollen is ripe, using a pair of forceps, sharp scissors or similar instrument. When the pistils have become receptive, flowers from the male parent, with ripe pollen, are introduced into the bag and shaken up, or the collected pollen is placed on the stigmas. As the flowers in a cluster ripen unevenly it is necessary to repeat the removal of stamens and introduction of pollen every two or three days until the desired number of fruits has set.

While this process is more rapid than the description might indicate, it requires time and care, which must be paid for when the seed is sold; so that producers who guarantee first generation crossed seed should obtain higher prices for such seed.

LIME-SULPHUR DWARFS POTATO PLANTS.*

F. H. HALL.

Bordeaux best for potatoes.

Lime-sulphur solution can not replace bordeaux mixture as a preventive of potato diseases. Orchardists who also grow potatoes hoped that they might use the lime-sulphur spray in the field as well as in the orchard and dispense with the bordeaux altogether, as it would be convenient to prepare only one fungicide; but a careful test made at this Station in 1911 proves the lime-sulphur harmful to potatoes. The plants in rows sprayed with lime-sulphur were dwarfed by the fungicide, died early and yielded about 40 bushels less to the acre than plants in check rows; while the bordeaux-sprayed rows produced 100 bushels to the acre more than the checks.

The test.

The first row of each of five series was left as a check, the second row received bordeaux mixture (6-6-50), the third lime-sulphur solution (1 to 40), and the fourth lead benzoate (1 lb. to 50 gals.). Each treatment was repeated six times, as the season was a long one, and all the rows were kept free from beetles by two applications of lead arsenate.

The dwarfing effect of the lime-sulphur was plainly evident by September 16 and became very noticeable in October. The plants were really smaller than those on the check rows, not merely appearing smaller through lack of foliage; for the stems were both shorter and of less diameter on the lime-sulphur rows. The lead benzoate plants were not dwarfed, but their condition was no better than that of the checks. There was no apparent burning of the foliage on any of the rows.

Parasitic diseases were comparatively harmless, as there was only a little early blight (very late in the season), and no late blight; but tip-burn seriously affected the plants of all rows except those sprayed with bordeaux, and injured even these somewhat, especially toward the north end of the field. The bordeaux-sprayed rows were still partly green when frost came, October 27, while most of the plants on the other rows had been dead a week or more at this time.

The long season gave the bordeaux the best possible opportunity to exert its stimulative influence, and the thorough spraying may have intensified the injury from the lime-sulphur; so that the test probably presents lime-sulphur in its most unfavorable light. As a whole, however, the experiment conclusively proves it unsafe to use lime-sulphur on potatoes and unwise to consider lead benzoate as a fungicide for potato diseases.

* A reprint of "Popular Edition" of Bulletin No. 347; see p. 193 for the Bulletin.

TEN YEARS OF POTATO SPRAYING.*

F. H. HALL.

Potato spraying a profitable practice.

For ten successive years in the present series of experiments, this Station has tested potato spraying as a regular operation in the culture of this crop. On its grounds at Geneva a profitable increase has been secured in each year of the ten; spraying three times during the season has resulted in an average increase of 69 bu. to the acre, and spraying every two weeks (5 to 7 times) has increased the yield of merchantable tubers 97½ bu. to the acre. In the duplicate series at Riverhead, Long Island, the gains have not been so great, owing partly to lighter soil and adverse climatic conditions. In only two years of the ten, however, was there a failure to secure a nice profit from the operation; while the average for the ten seasons is an increase of 25 bu. from three sprayings and 45¾ bu. from the fortnightly applications of the bordeaux.

As five of the ten years have been notably dry seasons, unfavorable to the development of blight and rot, and, consequently, not adapted to showing the benefit from spraying, it is believed that this series of tests proves beyond a shadow of doubt that potato growers in New York State should make spraying with bordeaux mixture a regular operation in their scheme of culture.

The results secured in the Station tests are confirmed by a nine-year series of farmers' business experiments, in which records

* This is a reprint of "Popular Edition" of Bulletin No. 349; see p. 209 for the Bulletin.

were carefully kept so that the exact financial gain or loss from spraying could be obtained. From six to fifteen potato growers co-operated with the Station in this work each year, the fields under test including from 60 to 225 acres annually. In all, there were 114 different trials and in only 20 cases did spraying fail to give a profit. That is 17½ per ct. of the acreage sprayed caused the owners a loss of $1,286.74; while the other fields gave a net profit, after all expenses had been met, of $20,786.75. Taking the experiments as a whole, failures and successes together, spraying resulted in an average gain of 36.1 bu. to the acre and an average net profit of $14.43 an acre.

Volunteer experimenters reporting to the Station give an even better showing, as the 205 experiments made by them in seven years give an average gain of 54.3 bu. to the acre. These last results are, of course, better than the average gains by farmers in the years reported, since growers are less apt to announce failures than successes; but in the farmers' business experiments failures and successes were all recorded alike. Even these results could be much bettered by more thorough work, as is shown by the acreage increases in yield shown by the Station tests. In these Station experiments, the bordeaux was applied very thoroughly, with a knapsack sprayer; so that efficient protection was given the plants. Such protection is not ordinarily secured by machine spraying by farmers; but care in application and "double spraying" have usually given profitable increases.

Single and double spraying.

During the last two years of the tests arrangements were made with several growers to "double spray" portions of their fields; that is, to go both up and down the same rows with the sprayer. Both of these years were very dry and spraying, therefore, of less benefit than usual. While there were some very surprising exceptions to the rule, the double spraying was profitable, as shown by the following table:

TABLE I.— RESULTS OF DOUBLE-SPRAYING AS COMPARED WITH SINGLE-SPRAYING

Location of experiment.	Times sprayed.	Increase or decrease in yield. Single-spraying.	Double-spraying.	Difference.	Expense of single-spraying.	Market price of potatoes.	Profit or loss.
		Bu.	*Bu.*	*Bu.*	*Per acre.*	*Cts.*	
Andover	4	33.5	88.4	54.9	$3 58	35	$15 63
Sterling Station	5-7*	—0.9	33.7	34.6	4 28	35	7 83
Glen Head	4	27.9	41.4	13.5	2 87	69	6 44
Jamesport	4	46.7	41.7	—5	4 53	60	—7 53
Southampton	4	7	—26.5	—33 5	2 72	55	—21 19
Cortland	4	19.4	60.5	41.1	3 54	60	21 12
Glen Head	5	2.2	21	18 8	3 66	103	15 71
Albion	7	11.9	49.9	38	8 52	60	14 28
Jamesport	5	8.7	28.2	19.5	7 40	90	10 15
Lancaster	4	—4.4	15.4	19.8	2 84	60	9 04
Ogdensburg	6	33.2	49.5	16.3	7 78	100	8 52
Phelps	4	1.1	18.8	17.7	4 16	70	8 23
Cassville	5	82.6	101 3	18.7	5 10	70	7 99
Andover	5	9.4	—7.9	—17.3	2 76	55	—12 27
Chateaugay	4	24.4	4.9	—19.5	4 10	65	—16 78
Averages	......	20.2	34.7	14.5	....	....	4 44

* There were three tests — one sprayed five times, the others seven times.

In this table the column "Expense of single-spraying" indicates the added cost of the second application, by which the acreage increase (or decrease) shown in the previous column was secured. This cost was taken to be the same as that for a single application. It will be noticed that even in these very unfavorable seasons the double sprayings increased the average yield over the single sprayings two thirds as much as did the single sprayings over no spraying. It is plainly the rule in potato spraying, as in most farm operations, that "thoroughness pays."

Results in ten-year series.

The last year, 1911, of the ten-year series of potato-spraying tests was very unfavorable to the potato crop, and to benefit from spraying, during the early part of the season, owing to the excessive heat and drought; but abundant rains later, with holding off of frost at Geneva until October 27, resulted in good yields. Tip burn was the worst trouble at Geneva, and this was apparently somewhat checked by spraying.

A little early blight affected the unsprayed rows, but there was no late blight in the field at any time. In spite of these unpromising conditions for spray benefit a difference between sprayed and unsprayed rows was evident from the middle of September until frost came; and the yields, as shown below, again proved spraying beneficial in spite of the absence of any very evident reasons for that benefit.

TABLE II.— YIELD BY SERIES AT GENEVA IN 1911.

Series.	Rows.	Dates of spraying.	Yield per acre.*	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13....	July 6, 20 and Aug. 17....................	225	15
II......	2, 5, 8, 11 and 14....	July 6, 20, Aug. 4, 17, 31, Sept. 15 and 30....	278	20
III......	3, 6, 9, 12 and 15....	Not sprayed............................	185	23

* Marketable tubers only.

Increase in yield due to spraying three times, 40 bu. per acre.
Increase in yield due to spraying seven times, 93 bu. per acre.

At Riverhead flea beetles were abundant. There was a little early blight, but no late blight or rot. Severe drought caused early death of the plants on all three series, thus reducing the yields to a very low point and preventing any chance of benefit from the spraying.

TABLE III.— YIELD BY SERIES AT RIVERHEAD IN 1911.

Series.	Rows.	Dates of spraying.	Yield per acre.	
			Bu.	*lbs.*
I......	1, 4, 7, 10 and 13.....	May 30, June 24 and July 12...............	134	30
II......	2, 5, 8, 11 and 14.....	May 30, June 14, 28, July 12 and 26.........	133	50
III......	3, 6, 9, 12 and 15.....	Not sprayed............................	133	20

Increase in yield due to spraying three times, 1⅙ bu. per acre.
Increase in yield due to spraying five times, ½ bu. per acre.

At both Geneva and Riverhead the tests were conducted as in previous years, each treatment being applied to five rows, each making one-fifth of an acre, and the rows alternating so that soil differences were neutralized as far as possible. "Bugs" were kept off the check rows by separate treatments of poison, and off sprayed rows by combining poison with the bordeaux. Rural New Yorker No. 2 was the variety planted at Geneva and Carman No. 1 at Riverhead.

The summarized results of the whole ten-years' tests are shown in Table IV.

TABLE IV.— SUMMARY OF THE TEN-YEAR EXPERIMENTS.

Year.	At Geneva.		At Riverhead.	
	Gain per acre due to spraying every two weeks.	Gain per acre due to spraying three times.	Gain per acre due to spraying every two weeks.	Gain per acre due to spraying three times.
	Bu.	*Bu.*	*Bu.*	*Bu.*
1902	123.5	98.5	45	27.7
1903	118	88	56	39 5
1904	233	191	96	56.5
1905	119	107	82	31.5
1906	63	32	53	21.5
1907	73.7	44	31	18
1908	39	29.5	15.7	10.7
1909	49.7	38.7	52.5	28.7
1910	63	22	25.5	14.7
1911	93	40	.5	1.1
Average	97.5	69	45.7	25

Farmers' business experiments.

The farmers' business experiments were managed, as usual, by the growers themselves, the Station merely specifying that check rows should be left unsprayed in a section representative of the field, and supervising the harvesting and weighing of these check rows and similar sprayed rows alongside. All other details were left to the judgment of the growers. Fourteen such tests were conducted in 1911, which are reported in brief in Table V.

TABLE V.— SHOWING RESULTS OF BUSINESS EXPERIMENTS IN 1911.

Experiment.	Area sprayed.	Number of times sprayed.	Increase or decrease in yield per acre.	Total cost of spraying per acre.	Cost per acre for each spraying.	Net profit or loss per acre.
	A.		Bu.			
Cassville	6	5	82.6	$5 10	$1 02	$52 72
Ogdensburg	4.6	6	33.2	7 78	1 30	25 42
Chateaugay	12	4	24.4	4 10	1 02	11 76
Greenwich	4.5	8*	21.7	6 40	80	8 79
Cortland	8	4	19.4	3 54	89	8 10
Dryden	8	5	22.7	5 32	1 07	7 16
Batavia	30	4	14.9	1 88	47	7 06
Andover	8.5	5	9.4	2 76	55	2 41
Plattsburgh	13	4	7.7	4 68	1 17	1 09
Jamesport	15	5	8.7	7 40	1 48	43
Albion	17	7	11.9	8 52	1 22	—1 38
Glen Head	15	5	2.2	3 66	73	—1 40
Phelps	14	4	1.1	4 16	1 04	—3 39
Lancaster	6	4	—4.4	2 84	71	—5 48

* Four double sprayings.

Average increase in yield per acre, 18.2 *bushels.*
Average net profit per acre, $8.09.

The growers who carried on these tests are P. S. Doolittle, Cassville; Andrew Tuck, Ogdensburg; O. Smith & Son, Chateaugay; P. C. Billings, Greenwich; G. H. Hyde, Cortland; D. R. Trapp, Dryden; G. A. Prole, Batavia; J. M. Greene & Son, Andover; Pardy Bros., Plattsburgh; Henry A. Hallock, Jamesport; Ora Lee, Jr., Albion; G. T. Powell, Glen Head; J. A. Page, Phelps and F. W. Handy, Lancaster.

The summarized results of the farmers' business experiments for the nine years appear below:

TABLE VI.— SHOWING RESULTS OF BUSINESS EXPERIMENTS IN 1903–11.

Year.	Number of experiments.	Total area sprayed.	Average increase in yield per acre.	Average total cost of spraying per acre.	Average cost per acre for each spraying.	Average net profit per acre.
		A.	Bu.			
1903	6	61.2	57	$4 98	$1 07	$23 47
1904	14	180	62.2	4 98	93	24 86
1905	13	160.7	46.5	4 25	98	20 04
1906	15	225.6	42.6	5 18	985	13 89
1907	14	152.75	36.8	5 90	1 18	17 07
1908	14	200.25	18.5	4 30	92	8 53
1909	12	203.14	24.4	4 15	835	9 55
1910	12	218.5	19.1	4 04	90	4 39
1911	14	161.6	18.2	4 87	96	8 09

Average increase in yield for nine years, 36.1 *bu. per acre.*
Average net profit for nine years, $14.43 *per acre.*

Volunteer experiments. No volunteer experimenters reported in 1911, but the summarized results of 205 such tests made in the seven years preceding 1911 are shown in the next table. These tests were made without Station supervision in any way and are probably less reliable than the farmers' business experiments, yet they help to show that spraying potatoes is too profitable a farm operation to be neglected.

TABLE VII.— SHOWING RESULTS OF VOLUNTEER EXPERIMENTS, 1904–1910.

Year.	Number of experiments.	Total area sprayed.	Average gain per acre due to spraying.		Average market price per bushel of potatoes at digging time.
		A.	*Bu.*	*lbs.*	*Cts.*
1904	41	364	58	28	43.5
1905	50	407	59	32	57.0
1906	62	598	53	6	44.5
1907	24	264	30	28	58
1908	11	74	66	18	66
1909	12	115	44	22	51
1910	5	218	68	—	45

Average gain for seven years (205 *experiments*), 54.3 *bu. per acre.*

Potato troubles during the year. Over the greater part of the State the growing season of 1911 was very dry. Consequently, late blight (*Phytophthora infestans*) occurred very sparingly. It made its appearance in a few localities, but came too late to cause material injury to the foliage. Neither was their much loss from rot although traces of it were found in a considerable number of fields in central and western New York. Early blight (*Alternaria solani*), also, was scarce. As in 1910, the leading troubles of potato foliage were flea beetle injury and tip burn. Tip burn, especially, was very prevalent.

Directions for spraying. In general, commence spraying when the plants are six to eight inches high[1] and repeat the treatment at intervals of 10 to 14 days in order to keep the plants well covered with bordeaux throughout the season. During epidemics of blight it may be advisable to spray as often as once a week.[2] Usually, six applications will be required. The bordeaux should contain four pounds of copper sulphate to each fifty gallons in the first two sprayings and six pounds to fifty gallons in subsequent sprayings.[3] Whenever bugs or flea beetles are plentiful add one or two pounds of paris green, two quarts of arsenite of soda stock solution or three to five pounds of arsenate of lead to the quantity of bordeaux required to spray an acre.

Thoroughness of application is to be desired at all times, but is especially important when flea beetles are numerous or the weather favorable to blight. The more frequently and thoroughly the plants are sprayed the better. There is no danger of injuring the foliage by too much spraying. Using the same quantity of bordeaux, frequent light applications are likely to be more effective than heavier applications at long intervals; e. g., when a horse

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[1] On Long Island an earlier spraying is sometimes necessary to protect the young plants from flea beetles which attack them severely while they are coming up. For the best success in the control of bugs it is necessary to spray with bordeaux and poison just as soon as a majority of the first brood are hatched. Usually, this occurs when the plants are six to eight inches high. Spray applied three days or more before the bugs hatch will fail to kill many of them, because, in the interval the plants make considerable new growth upon which the bugs can feed with impunity and cause considerable damage before it is time to make the next regular spraying.

[2] On the south shore of Long Island between Southampton and Amagansett this is frequently necessary.

[3] It can not be definitely stated what formula is the best one to use. Much depends upon the quantity used per acre and the manner of its application. Weak bordeaux applied in the form of fine spray which covers the plants thoroughly may give better results than stronger bordeaux carelessly applied in the form of coarse spray. Both the cost of chemicals and the expense of application must be taken into consideration. It is plain, however, that the mixture should be strengthened as the season advances and the danger from blight increases. None of the ready-made bordeaux mixtures on the market are as good as the home-made bordeaux. Neither can the lime-sulphur solution be profitably substituted for bordeaux in spraying potatoes (See Bul. 347 of this Station). In the preparation of bordeaux the writers prefer to use stone lime rather than any of the "prepared" limes.

power sprayer carrying but one nozzle per row is used, it is better to go over the plants once a week than to make a double spraying once in two weeks. In the first two sprayings, while the plants are small, one nozzle per row may be sufficient; but when the plants become large at least two nozzles per row should be used. Large vines are especially liable to blight and should be sprayed very thoroughly. Such vines will be somewhat injured by the wheels of the sprayer, but the benefit from spraying will far outweigh the damage done.

A single spraying is better than none and will usually be profitable, but more are better. Spraying may prove highly profitable even though the blight is only partially prevented. It is unsafe to postpone spraying until blight appears. Except, perhaps, on small areas, it does not pay to apply poison alone for bugs. When it is necessary to fight insects bordeaux mixture and poison should be used together. For the best results, spraying should be continued as long as the plants live. It is a mistake to discontinue spraying because the weather is dry and no blight present. A late attack of blight may result in heavy loss from rot. As a rule, those who spray most obtain the largest net profit.

SOME NEW APPLES FROM KNOWN PARENTS.*

F. H. HALL.

Apple varieties mainly chance seedlings.

The apple must be called America's leading fruit, yet almost no careful breeding of it has hitherto been done. Of 698 varieties described in "The Apples of New York," both male and female parent are certainly known for only one variety; one parent is known and the other guessed, for two other kinds; four are held to be sports from known varieties; and the female, or seed-producing, parent, is given for 39 kinds. Of the remaining 650 varieties, 71 are said to be seedlings (of unknown parentage); but, for the great majority of the kinds nothing is positively known as to the origin. This poor showing for scientific, commercial or careful amateur apple breeding is due to several causes: Breeding tree fruits of any kind is time-consuming and space-demanding; the pecuniary rewards for individuals are inconsiderable or altogether wanting; institutions organized to do plant breeding have felt obliged to work in other fields where results could be more quickly secured and would mean more when obtained; and lastly, plant breeding, especially breeding of tree fruits, has until recently seemed largely a matter of guesswork and chance — a process most of whose fundamental laws were unknown.

* A reprint of "Popular Edition" of Bulletin No. 350; see p. 443 for the Bulletin.

New laws of breeding revealed

But within the past ten years plant breeding has made rapid advances, owing to the discovery, *after it had lain hidden for half a* century, of work which established some very elementary laws of heredity. These laws make it possible to work with plants, and, to quite an extent, with animals with a certainty of securing the desired results with much less effort and time than in former years.

This old work of Johann Mendel established the fact that some of the characters, of both plants and animals, are inherited unchanged, passing down through each subsequent generation. Many of them may be hidden in the first generation of progeny and in a fraction of the descendants of each subsequent generation by the "dominance" of stronger, opposed, or differing, characteristics of the same group. But both the "dominant" and the "recessive" (weaker or hidden) character of a Mendelian pair reappear in pure form in part of each generation after the first; so that the descendants of two parents, both showing the same one of these pure characters, will always be like their parents in respect to this character.

Now, the problem of the breeder is to ascertain what characters follow this law — for not all do — and to secure the ones desired in pure form and in suitable combinations. When once secured as desired in two parents, the descendants may be depended on to show the same characters and not to "revert" to some form not wanted. But, even simplified as it is, the problem is still very complex; for the features or characteristics we think of as separating one plant or animal from another may each be made up of two or more heritable characters; and the possible combinations, in any individual, of these varied "unit characters" are exceedingly numerous and varied. All these variations must be secured and checked by growing multitudes of seedlings, of at least two generations, before we can be positive of our ground on more than a few characters.

For this reason, much careful work must be done with any of the species or varieties man uses or desires to use in breeding. With the apple, as already indicated, so little breeding work has been done that we know almost nothing of the inheritance of characters; therefore the information secured from work at this Station in making crosses between eleven varieties of apples is published at this time, though admittedly incomplete.

Handicaps in apple breeding.

These breeding experiments were begun before Mendel's laws of breeding were familiar to more than a few scientists, and were not made with any purpose of testing those laws. Since we know so little of the origin of the varieties used we are handicapped at the start in interpreting the results by the new laws; as we can not tell whether we are working with pure characters, separated out by running through two or more generations, with dominant characters showing in the first cross and hiding their recessives of the Mendelian pairs, or with "blended" characters. It is very probable, however, that, with regard to many characters, the apple varieties of to-day are themselves crosses; so that when we again cross these varieties, some characters split up into pure dominants and recessives and give us a clue to the transmissibility of the parental characteristics. The only way this can be proved, though, is by growing large numbers of seedlings from self-fertilized seeds of both parent and descendant varieties — a matter of great difficulty in the apple, which does not readily self-fertilize and, when it does, appears to give seedlings of inferior vigor. Work along this line will give results of scientific value and should, logically, precede presentation of data or conclusions regarding the inheritance of characters. Such work is in progress at the Station, hindered by the apple's opposition to self-pollination; but as it must be at least ten or twelve years before trees of the second generation are in bearing it seems best to give, now, the practical results of the apple crosses made, under Prof. S. A. Beach's supervision, in 1898 and 1899.

Varieties crossed and seedlings produced.

During these two seasons 148 crosses were made from which the following seedlings have fruited, first from grafted wood and later from the seedling trees: From Ben Davis x Esopus 4; from Ben Davis x Green Newtown 13, from Ben Davis x Jonathan 11, from Ben Davis x McIntosh 11, Ben Davis x Mother 20, from Esopus x Ben Davis 29, Esopus x Jonathan 2, McIntosh x Lawver 1, Ralls x Northern Spy 9, Rome x Northern Spy 1, and Sutton x Northern Spy 5. These seedlings show marked vigor and are noticeably healthier and more productive than others from self-pollinated seeds, either of Hubbardston or Baldwin, of which considerable numbers are growing at the Station, comparable in age to the crossed seedlings.

Contrary to the usual belief, these seedlings have not "reverted to the wild;" but show to a marked degree the characteristics of the parents. So evident is the inheritance of parental characters that one familiar with the varieties crossed could in most cases select the parents for individual seedlings. Indeed, so surprisingly uniform has been the transmission of the good qualities of the selected varieties that the fruit of 14 of the 106 fruiting seedlings is considered as good or better than either of the parents, and the trees are satisfactorily productive. These seedlings have been named, from counties in New York State, and are already distributed to some extent among apple growers.

These varieties are, with the briefest possible description of each, the following:

Clinton. (*Ben Davis x Green Newtown*).— An attractive midwinter apple of medium size, resembling Green Newtown in shape and quality, but of a handsome red color.

Cortland. (*Ben Davis x McIntosh*).— A large apple of the McIntosh type, in season from November to February, and promising commercially.

Herkimer. (*Ben Davis x Green Newtown*).— A fruit for late

winter, of good quality and handsome appearance. It resembles Ben Davis externally and internally but is much better in quality.

Nassau. (*Esopus x Ben Davis*).— A medium-sized apple of attractively contrasting red and yellow color, much better in quality than Ben Davis but hardly equal to Esopus. Its season is late fall.

Onondaga. (*Ben Davis x McIntosh*).— A medium-sized, midwinter apple, of very handsome greenish-red color almost entirely overspread with dark McIntosh red splashed and mottled with carmine. It is of the McIntosh type, but more conical in shape, desirable for cooking and would be liked by many as a dessert apple.

Oswego. (*Sutton x Northern Spy*).— Larger than Northern Spy, more conical, brighter in color and equal in quality though of a different flavor. It is a late winter and spring variety.

Otsego. (*Ben Davis x McIntosh*).— Though rather small, this apple was thought worthy of propagation because of its handsome, bright red color, good quality, small core and few seeds. It is in season in early winter.

Rensselaer. (*Ben Davis x Jonathan*).— Of Jonathan type, exceedingly attractive in color and of fine flavor, though of only medium size. Its season extends through the winter months.

Rockland. (*Ben Davis x Mother*).— This cross resembles Mother in size, shape, color, texture, flavor and quality and should be especially desirable as a dessert fruit in early and midwinter. It is most pleasing in appearance, though small.

Saratoga. (*Ben Davis x Green Newtown*).— A large, late winter and spring apple, nearly or quite as good as Green Newtown. The bright, purplish red color is spread over greenish yellow and is splashed and mottled with crimson, making it very bright and attractive.

Schenectady. (*Ben Davis x Mother*).— A remarkably handsome early winter variety, red in color with carmine mottles and splashes and brightened by greenish yellow undercolor. It is

large in size and of fine roundish conic shape. While not quite high enough in quality for a dessert apple it is much better than Ben Davis.

Schoharie. (*Ralls x Northern Spy*).— Of Northern Spy type, good size but not large. It has the delicious flavor and aroma of the Spy but its flesh is more yellow. It is in season in late winter and spring and is desirable for either cooking or dessert, but is a trifle dull in color.

Tioga. (*Sutton x Northern Spy*).— Another most promising, late winter and spring apple of Northern Spy shape, of high quality and handsome appearance. It is large in size, yellow in color, blushed, mottled and faintly splashed with pinkish red.

Westchester. (*Ben Davis x Green Newtown*).— Of Green Newtown shape, but even better in quality and with the attractive Ben Davis color. It is a medium-sized, early winter, dessert apple.

Beside these varieties definitely selected for naming and propagation, as many others have been retained for further testing as promising. This is a remarkably good showing for seedlings of any kind and would seem to promise satisfactory returns for the time, space and expense involved in future apple breeding.

New varieties almost wholly from crosses.

It is by crossing like that in these experiments that we must hope to secure valuable new varieties of apples. There is little or no evidence to show that this fruit can be improved by selection within the variety; we have no record that any good apple has come from self-pollinated seeds; and the number of useful sports is small and conditions under which these originate as yet wholly unknown. Chance seedlings may, of course, give good varieties; and it is probable that most of our cultivated apples have come from such accidental crossing; but if as good results as were secured in the experiments here discussed can be counted on to follow the crossing of selected parents it is a waste of time and energy to grow the multitude of seedlings

necessary for selection from natural crossing. The technic of artificial crossing is simple, involving merely the selection and bagging of unopened flowers on the male and female parents, removal of stamens from the female flower before pollen has matured and the introduction of pollen from the protected male flower when the stigma of the female flower is receptive. Shortly after the fruits have set the paper bags are removed and sacks of mosquito netting substituted.

When we know more of the inheritance of apple characters in general it should be a comparatively easy matter to select parents that carry the ones we desire and to unite them in combinations superior or at least different from any we now have. We can not in this way, however, expect to secure new characters. Such deviations, if they ever arise, must come from sports, or from crosses outside the range of cultivated varieties.

How qualities inherit.

As indicated before, it is not safe to make generalizations from the progeny of a first cross, as first generation crosses inherit the characteristics of both parents unseparated, it being only in the second and subsequent generations that the Mendelian pairs segregate (that is, separate in pure, inheritable form in part of the seedlings); but the chances are great that in any crossing of apple varieties to-day we are really combining crosses, so that some pairs of characters are split up in what is really the second generation so far as these characters are concerned. That is, if we cross two red varieties, and secure some yellow seedlings, it is very good evidence that one or more of the unknown ancestors of the parent varieties must have been yellow-fruited and that the yellow seedlings are pure for that character.

Even if this be not true it still seems worth while to indicate what seem to be the heritable characters of the parents in these experiments; for any variety obtained in this way is continued by grafts or buds (parts of the original plant) and so remains con-

stant, being subject to none of the fluctuations that arise in continuing a variety from seed.

Also, if certain characters of a parent variety reappear with considerable constancy in a considerable number of seedlings of that variety, especially if the cross is made with two or more other varieties, it is fair to assume that these characters will also appear when other crosses are made, even though we can not say that the character is a pure dominant or recessive. This would be true, in particular, if any variety were prepotent in regard to some of its characters, as appears to be the case with Ben Davis in these crosses; that is, many of the Ben Davis characters are apparently dominant characters of Mendelian pairs, so that they appear in the first generation crosses, no matter what the characters of the other parent may be.

Some characters transmitted in these crosses.

Among the best of the eleven varieties used in this breeding work, so far as production of desirable new kinds is concerned, are Northern Spy, with three named varieties and four promising ones out of 15 seedlings; McIntosh with two good and four promising seedlings out of 12, and Ben Davis, with every eighth seedling worthy of naming and nearly as many more of enough merit to be retained for further testing. Green Newtown was crossed only with Ben Davis, but seems a very desirable parent, as four seedlings out of thirteen, or more than 30 per ct. of those grown, received names as desirable new varieties.

Northern Spy gave large-fruited seedlings in most cases, some of them larger than either parent; but in the cross with Ralls, a fruit of moderate size, small fruited descendants appeared in such proportions that it is probable that some ancestor of the Spy as well as of Ralls must have borne small fruit. The Spy also impressed its own shape when crossed with Sutton, but not when crossed with Ralls. It gave some yellow-fruited seedlings when

crossed with Sutton, but in other crosses gave only reds of more or less intense shade. No sweet apples appeared among the Spy seedlings.

McIntosh, though a sub-acid variety and crossed with two other sub-acid kinds, gave two sweet seedlings. Most of its progeny were red, but four of them were yellow proving McIntosh a bearer of that color in spite of its dark red skin. The pure white of its flesh is evidently a weak character as it was hidden in most cases by the yellower flesh of the other varieties of the crosses.

Ben Davis carries sweetness as a recessive character, since some of its descendants were sweet in each of the crosses where several seedlings were obtained. It did not notably impress its shape when crossed with Jonathan or Green Newtown; but did so about equally with the other varieties with which it was bred. In size, most of its descendants are intermediate between the parents, but with Green Newtown some of the seedling fruits are larger than either parent and none smaller. In color, all the Ben Davis seedlings are red unless the yellow could come from the other parent.

Green Newtown appears prepotent in transmitting its shape, the obliqueness of this parent appearing in nearly all the offspring; and all are equal or superior in size to either parent. Nearly one-fourth of the Green Newtown seedlings are sweet, and five out of the thirteen showed yellow color.

Jonathan carries red color only, and gives its shape to most of its progeny; Mother probably transmits red only, and gave eight sweet apples among its twenty descendants; and Ralls probably carries only red and a strong shape-determining factor.

Regarding other varieties the data are too limited to justify specific statements.

Summary.

The large percentage of good or promising new varieties obtained in this work, appears to promise favorable results in further apple breeding; but the difficulties in the way must not be forgotten.

We know, as yet, almost nothing of the unit characters in apples, and the way they are inherited, and until this foundation knowledge is secured it will be difficult to select, with any degree of certainty, the parents whose progeny will combine the qualities we desire in our new variety.

The determination of the factors by which the various characters are transmitted will be no easy task; for work in other fields proves that many characters depend not on one factor alone, but on several that may be separately inherited, and the experiments here recorded indicate that this is markedly true of the apple. Shape, size and color of fruit may depend upon the presence or absence of several factors. Some factors or characters may not appear at all in the first generation, and this skipping of a generation may complicate matters and involve a second crossing and wait of ten or twelve years before we secure the combination the parent characters led us to expect. To secure all the possible combinations from any cross we must have large numbers of plants, which is difficult and time-taking with apples.

There is liability also, in selecting parents, of mistaking qualities due to environment rather than to the constitution of the plants themselves; for these qualities, as acquired characters, are not inherited; though the advocates of "pedigreed stock" would lead us to suppose that they are.

In some cases, also, characters do not act as Mendelian pairs; but blend rather than segregate in crossing, so that the seedlings may, in some desired respect, be intermediate between the parents, giving no combination containing the one specially good quality we wish.

These and other difficulties confront the apple breeder; but the importance of the fruit, and the help we have in Mendel's laws, making breeding a problem and not a riddle, certainly justifies much careful, continuous work with this queen of American fruits.

LIME-SULPHUR NOT A GOOD POTATO SPRAY.*

F. H. HALL.

Lime-sulphur dwarfs potato plants.

From a spraying test made at this Station in 1911 and reported in Bulletin No. 347, the conclusion was reached that "lime-sulphur cannot replace bordeaux mixture as a preventive of potato diseases." A similar test made in 1912 strengthens this conclusion. The lime-sulphur treatments caused dwarfing of the plants as in 1911, did not repress but seemingly increased the damage from tipburn, did not keep off flea-beetles, apparently did not check late blight and rot, and resulted in greatly decreased yields as compared with rows sprayed with bordeaux mixture.

Plan of test.

The rows under test were arranged in sections, as in other potato-spraying work at the Station. The first row in each of the five sections was sprayed with bordeaux mixture (6–4–50), the second row with concentrated lime-sulphur solution diluted to give the standard strength for foliage (1 to 40), and the third row was left untreated. Potato beetles were combated by the use of arsenate of lead, and were well controlled on all rows.

Troubles.

Flea-beetle injury was slight, but decidedly least on bordeaux-sprayed rows; tipburn appeared in August and affected the checks and lime-sulphur rows badly, the latter much the worst, so that nearly all the plants on the lime-sulphur rows were dead several days before very many had died on the check rows, while the plants sprayed with bordeaux showed little of the trouble at any time; dwarfing of the plants treated with lime-sulphur was noticed by Aug. 20 and the difference in size grew more pronounced as the season advanced; late blight appeared very late in this field, the attack not being noticeable until most of the plants on the lime-sulphur rows were dead from dwarfing and tipburn, so that the subsequent rot did less harm on these rows than on the check rows owing to the few living blighted plants to serve as centers of rot infection.

Gains and losses.

The check rows yielded at the rate of 240½ bu. to the acre, of which only 165 bu. were marketable owing to the large amount of rot. The lime-sulphur rows gave 39 bu. less of total yield than the checks, but because rot had not spread so fast gave a slight increase (6 bu.) in marketable tubers; and the bordeaux-sprayed rows outyielded the checks by 48 bu. in total product and 111½ bu. in marketable potatoes.

* A reprint of "Popular Edition" of Bulletin No. 352; see p. 201 for the Bulletin.

MACHINE MILKING DOES NOT AFFECT MILK FLOW.*

F. H. HALL.

Milking machines merit attention.

The dairy industry of today needs the milking machine. In dairying, as in other lines of farming, the labor problem is difficult of solution; and herd owners would welcome gladly an economical, efficient machine that would enable them to milk their cows with fewer men or permit an increase in the size of the herds without adding to the labor pay-roll. Inventors and manufacturers realize this need and have tried to meet it by putting on the market milkers of many makes and types. Some of these machines have now reached an advanced stage of mechanical perfection, so that they really milk cows easily, rapidly and completely. But before any of these machines can be pronounced an unqualified success it must receive long, careful trial and be studied from different standpoints.

Pure milk a prime consideration.

In any factory a new machine, to secure attention, must promise economy in labor without material lowering of quality. In some cases the machine-made product may not be quite so good as the hand-made article it replaces, but the cost reduction be great enough to more than counterbalance the slight falling off in quality; and the machine is installed. In the dairy, however, quality is the essential consideration. With the present day demand for clean, sweet, healthful milk, any mechanical device whose use increased the numbers of bacteria in the milk produced would not be generally used however efficient and economical it might be in milking the cows. This was a serious

* A reprint of "Popular Edition" of Bulletin No. 353; see page 57 for the Bulletin.

defect in milking machines first on the market. The first machine tested at this Station, the Globe, could not be kept clean easily, which, with other faults, condemned it; and with the earlier types of the milker now in use, the Burrell-Lawrence-Kennedy, much care was necessary in order to secure clean milk. With the improved forms of this milker, however, as shown by repeated careful tests announced in Bulletin 317 of this Station, there need be no difficulty in keeping the counts of bacteria as low as in ordinary hand milking.

The precautions necessary in securing clean milk with the improved form of this milker are few:

(1) Those parts of the machine through which the milk passes must be rinsed thoroughly after each milking, using in succession cold water, hot sal-soda solution or similar cleansing material, and hot water; and the teat cups and rubber tubes must be kept, between milkings, in a strong brine solution (10 per ct.) or similar germ destroyer. Once a week all parts of the machine touching the milk should be thoroughly washed and steamed.

(2) The ample, but few and simple, air-filters must be kept well filled with fresh, dry cotton tc prevent entrance into the machine of germ-laden dust.

(3) Dropping teat-cups on the floor or any similar carelessness in handling the machine must be avoided, since such accidents produce marked increases in the bacterial counts of the milk.

Previous studies of effect on flow.

Milking-machine studies at colleges or stations began as long ago as 1895 and since that time ten or twelve tests have been reported in which direct or indirect data were secured relative to the effect of the machines on milk flow. On the whole, the differences in quantity of milk produced by machine milking and hand milking were not great. In these tests, in many cases the numbers of cows were small; in others the periods were short so that it was impossible to say whether any shrinkage shown was due to the character of the milking or merely to a change in method; and in many instances the influences of advancing lactation were not properly balanced. Yet the summarized conclusion which might have been drawn from

these tests — that the milking machine exerts only slight, if any, adverse influence upon milk flow — is well sustained by the much more numerous, longer, carefully-balanced comparisons made in the Station tests here reported.

Machines used.

In two of the earlier tests at other stations the machines used and rejected differed from the type used in all later tests, including those at this Station. One of the early milkers used was a nonpulsating, suction machine, and the other exerted a combined pressure and suction effect. All the other machines whose tests have been reported, in America at least, have used the principle of the interrupted vacuum, by which the action of the calf's mouth is imitated rather than that of the hand milker's fingers. This is the principle employed in the B-L-K machines, which are the ones tested at the Station and which are at least typical of, if not the same as, those used in a great majority of the other tests. In these machines the application and relaxation of the vacuum-produced suction is controlled by a "pulsator" which forms an integral part of the head of the pail used. The teat-cups, by which direct attachment to the udder is made, are conical or funnel-shaped metal tubes with wide-flanged mouths to receive the teats. These mouths are partially closed with ring-shaped, heavy rubber curtains which make air-tight connections with the udder. In the older types of machines from six to eight sizes of teat-cups were required to fit all the cows of our herd, but with the new form one size of cup milks the herd more efficiently than did the many sizes previously used. This, of course, simplifies work with them and shortens the time needed. With these cups, also, the amount of "strippings" from the cows has been reduced to a practically negligible amount; and with them two cows were satisfactorily milked that would have been dropped from a hand-milked herd.

Station tests on milk flow.

In 1906–7 the cows in the Station herd were milked by hand and in 1907–8 by machine, but since such alternate-year comparisons of hand and machine milking could not equalize the influence of advancing age of the cows and climatic conditions affecting food supply, it was thought best to divide the herd in

halves as the cows freshened in 1908–9 and to milk each cow by hand and machine in alternate periods of lactation. In this division the herd was balanced as carefully as possible with regard to age and productive ability; and in subsequent changes due to the dropping out of cows by reason of age, accident, illness, sterility, etc., and the addition of others to maintain the herd, the same idea of preserving the balance has been kept in mind.

The work has now been carried through the lactation periods for 1910–11. In all, 29 cows have been compared during two or more lactation periods, including five periods each for five cows, four periods each for three cows, three periods each for nine cows and two periods each for twelve cows, making 88 complete lactation periods. During 43 of these periods the cow was milked by hand and during 45 by machine. Taking the data just as they stand and comparing the yields when any cow was milked by the two methods during successive periods, it would appear that 32 such comparisons favor hand milking and 23 favor machine milking. But it is hardly fair to include all the data. In the several years through which the tests ran, the yields of several of the cows were abnormal for at least one lactation period, owing to mishaps of one kind or another. Six young cows calved prematurely and three suffered so severely from indigestion that their yields were seriously affected. Leaving out these abnormal lactation periods there remain 24 comparisons in favor of hand milking and 19 favoring the machine. These figures apparently indicate a slight gain in production in favor of hand milking; but, as will be shown later, the actual mathematical differences in yield are so slight, considering the two groups as a whole, that the omission of a very few cows whose yield showed great fluctuation would shift the balance in either direction.

As shown in Table I, which includes all the data unaffected by noticeable disturbing factors, the final balance in favor of hand milking is only 6,000 lbs., merely the slightest fraction over 1 per ct. of the total production.

In making the table several of the cows were included that were milked more periods by one method than by the other, which might be considered unfair; so in Table II the comparison is restricted to an equal number of lactation periods for each cow by each method.

TABLE I.— ANNUAL AND TOTAL VARIATION IN MILK YIELD APPARENTLY DUE TO METHOD OF MILKING.
(Includes all satisfactory data.)

Number.	Hand, 1906.	Machine, 1907.	Machine, 1907.	Hand, 1908.	Machine, 1908.	Hand, 1909.	Hand, 1908.	Machine, 1909.	Machine, 1909.	Hand, 1910.	Hand, 1909.	Machine, 1910.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	5,821	6,456			7,455	7,595					7,595	5,666
2	5,247	4,765	4,765	6,085								
3	7,009	6,918	6,918	5,970								
4	4,870	4,208	4,208	6,310			6,310	3,502	3,502	7,194		
5	3,836	3,431										
6	4,187	5,305										
7	8,541	7,583										
8	7,649	7,434	7,434	7,366			7,366	6,746	6,746	9,446		
9	11,596	9,795	9,795	9,059								
10	6,557	10,751										
11	6,643	7,170	7,170	6,027			6,027	6,928				
12	7,844	8,881	8,881	7,792								
13	5,429	5,588			7,136	8,492					8,492	6,961
14	6,601	5,704										
15	7,106	7,067										
16							6,920	6,808				
17											7,217	6,683
18									7,382	4,302		
19									8,156	8,175		
20							5,533	5,798				
21					5,733	5,344					5,344	5,347
22											6,369	6,589
23					6,391	6,895						
24											5,121	6,778
26									7,174	8,021		
29											4,785	6,318
Totals	98,936	101,056	49,171	48,609	26,715	28,326	32,156	29,782	32,960	37,138	44,923	44,342
Group balance		2,120	562			1,611	2,374			4,178	581	
Annual balance		2,120	562				3,985				4,759	

Final balance (in favor of hand milking), 6,062 lbs. = 1 per ct. of total (574,114).

TABLE II.—YIELDS OF COWS MILKED BY HAND AND MACHINE.
(Including only balanced periods for each cow.)

Number.	Hand, 1906.	Machine, 1907.	Hand, 1908.	Machine, 1908.	Hand, 1909.	Machine, 1909.	Hand, 1910.	Machine, 1910.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	5,821	6,456		7,455	7,595			
2	5,247	4,765						
3	7,009	6,918						
4	4,870	4,208	6,310			3,502		
5	3,836	3,431						
6	4,187	5,305						
7	8,541	7,583						
8	7,649	7,434	7,366			6,746		
9	11,596	9,795						
10	6,557	10,751						
11	6,643	7,170	6,027			6,988		
12	7,844	8,881						
13	5,429	5,588		7,136	8,492			
14	6,601	5,704						
15	7,106	7,067						
16			6,920			6,808		
17					7,217			6,683
18						7,382	4,302	
19						8,156	8,175	
20			5,533			5,798		
21				5,733	5,344			
22					6,369			6,589
23				6,391	6,895			
24					5,121			6,778
26						7,174	8,021	
29						6,318	4,785	
Totals	98,936	101,056	32,156	26,715	47,033	58,872	25,283	20,050

Total machine	206,693
Total hand	203,408
Balance (in favor of machine)	3,285 = 0.8 per ct. of total (410,101).

As will be seen, this method of handling the data throws the balance toward machine milking, but again the difference is too slight to have any meaning, since it is less than 1 per ct. of the whole yield. In other words, the effect of milking upon the productivity of the cows is less than the normal fluctuation in yield from year to year due to such marked variation in yield of individual cows as might occur in any herd of considerable size. Of four cows milked by machine in 1906–'7 and again in 1907–'8 after division of the herd, one showed a change of 1,000 pounds in flow the second year, and another a change of 1,500 pounds; while data from Maine Station reports show a change of 5.6 per ct. in yield of a herd of 13 cows in successive years, and similar data from Wisconsin from a herd of 27 cows show a change of more than 1 per ct.

Machine milking does not change flow.

From this work, then, extending over five years and including a large number of lactation periods, the only conclusion possible to draw is that machine milking, if properly done, does not influence the flow of milk to any extent capable of measurement. Of course, poor management of the machines and careless handling might bring down yields; but so also a careless, inefficient hand milker may "dry off" a good cow in a few weeks.

Experts not necessary for milkers.

It is undoubtedly true that not every good hand milker would be able to handle a machine with equal success; but no remarkable qualities are necessary for efficient machine management. During the tests of the B-L-K machines at the Station, six men have run them for periods varying from three months to three years and none of them has failed to do fairly satisfactory work with the milkers. These men probably represent fairly well the better class of farm workmen; and none of them was selected for any special ability to operate machinery. The essential qualities in running a milking machine are merely carefulness, willingness to follow instructions and reasonable intelligence.

Time-saving by machines. In Station work it has been necessary to weigh and record each cow's milk separately; so that it has been inadvisable for one man to handle more than two machines, each milking two cows; and the operations have undoubtedly been done a little more carefully and a little slower than would be necessary in a commercial dairy. The data given for labor are, therefore, very conservative. They are based on accurate records of the time consumed by each step of the afternoon milking on 144 days in 1911; and on records of the time required each day for a month in washing and otherwise completing the cleaning of the machines, this last work being done in the dairy building, not at the barn.

Based on the use by one man of two machines in milking 15 cows, the time consumed each day would be as follows:

Preparing machines night and morning.....	6.72	minutes
Milking 30 cows (15 night and morning)....	88.20	minutes
Rinsing machines at barn night and morning.	15.36	minutes
Cleaning teat-cups and tubes (done weekly).	2.61	minutes
Washing remaining parts of machines......	8.13	minutes
Total time required to milk 30 cows....	121.02	minutes
Average time required to milk one cow.	4.034	minutes

Under commercial conditions this time could be decidedly lessened; and the advantage would increase as the number of cows milked increased. Fifteen is probably as small a number as will be found profitable in connection with present machine milking; since with this number of cows approximately one-third of the time is spent in operations other than the actual milking. As the number of cows increased this extra consumption of time would become relatively less and the average time required for each cow would decrease. It is possible, also, where detailed records are not kept, that one man could handle more than two machines and thereby reduce the labor cost.

Economy. As Station figures show that it takes seven minutes for a hand milker to milk a cow, record the weight and pour the milk on the cooler, it is evident that the machines do economize labor. As to

whether, or under what conditions, their installation would be financially profitable, data are lacking. Owing to rapid and repeated changes and improvements in the milkers used in these tests and the substitution of new pails and parts, it has been impossible to measure the deterioration of the machines or to get any very definite idea as to the cost of maintenance. Until these data can be secured, possibly not for a long period of time, each herd owner will have to decide for himself whether the saving in labor indicated above will justify him in installing machine milkers.

The Station experience proves that such machines, at least the one used by us, can be readily handled by the better grade of farm laborers, that they can easily be made to produce milk with very satisfactory bacterial counts, that they do not injuriously affect the flow of milk and that they will lessen the amount of human effort necessary to milk cows.

NEW YORK GRAPES ON NEW ROOTS.*

F. H. HALL.

A pest proves a benefit.

About 1860 an insect was introduced into France that threatened the very existence of the vineyard industry in that country. The phylloxera, a tiny root-feeding plant-louse from America found the thick, tender, juicy roots of the European wine grape just to its liking and French climatic conditions exactly suited to its rapid increase. In a few years, its wide-spreading devastations caused a feeling almost of terror among vineyardists; for insecticides proved powerless to check its destructive advance.

But in eastern America, the home of the phylloxera, the insect does little harm to the many native species of grapes. Here was a suggestion; so the French vineyardists brought over American stocks to furnish phylloxera-resistant roots and grafted on these plants cions of their favorite varieties. The phylloxera found the tough, dry, woody roots of American species, particularly those of the riverside, or winter, grape, as little to their liking in France as in America and the vineyards were saved. More than this! The European varieties on the new roots often gave better grapes than ever before. Some kinds that would grow only poorly, except on certain soils or in favored localities, proved much more tractable on the roots of some American species; other kinds were changed in season of ripening that they reached better markets; and, in other ways, perhaps less important, grafting of varieties on new roots worked to the advantage of the grape-growers. The

* A reprint of "Popular Edition" of Bulletin No. 355; see p. 489 for the Bulletin.

advent of the phylloxera really widened the possibilities of the European grape. In California, where the European grape (*Vitis vinifera*) is grown, as well as in France, grape-grafting has been studied and practiced with zeal and has undoubtedly aided greatly in the development of the wine, raisin and dessert-grape branches of that State's horticulture.

Grafting useful abroad, why not in New York?

While the phylloxera is not a dreaded pest in America east of the Rockies, and root-grafting is not here essential to the existence of vineyards, has not this process possibilities in eastern grape-growing? Some of our very best eastern grapes are commercially of little value because of defects which grafting has partially or wholly removed in case of other varieties in France and California; why is there not promise that similar results will follow if the combinations of root and cion are studied as carefully for our varieties and our conditions?

Varieties developed from our native species are exceedingly diverse as to soil requirements. Those derived from *Vitis rupestris,* the sand grape, or rock grape, thrive well on hard, dry soils; those from *Vitis æstivalis,* the summer grape, bunch grape, or blue grape, do well on light, thin soils. Descendants of the fox grape, *Vitis labrusca,* prefer loose, hard, sandy or gravelly soils, while those varieties whose parent species delight in the warm, moist, river banks (*Vitis riparia*) do best in the vineyard on rather heavier soils than those preferred by other grapes. In response to heat or cold, shade or sunshine, moisture or drought, in susceptibility to insect and fungus diseases, in productivity, in longevity and in size of vine, these different species show great variations; and in the vineyard, propagation, cultivation and spraying must be modified to suit the varied types. It seems entirely logical to suppose that the chances of betterment through grafting upon one of these diverse types of root stocks some of our cultivated varieties (which are derived from eight or nine distinct species) are as great, if not greater, than in grafting the Vinifera varieties upon these stocks in France.

Vineyard experiment located.

Hope that this might be true inspired an experiment along this line by the station. Work was begun upon this vineyard in 1902 and since 1908 many of the vines have given crops so that it seems time to report progress. In its development as an experiment, however, the vineyard has been practically a failure; since the vines have had many more than their fair share of mishaps and calamities. But in spite of untoward happenings that make the actual data secured scanty and irregular, the general behavior of the vines has been such that growing American grapes on roots other than their own must be considered a promising method of vineyard improvement, at least for the growth of choice varieties and possibly for the commercial vineyard.

This experimental vineyard was located in the Chautauqua Grape Belt on the farm of Mr. I. A. Wilcox of Portland, Chautauqua county. The experimental plats were located on two soils; one plat on Dunkirk gravel contains about an acre on which were set six hundred vines, and the other plat on Dunkirk clay contains about two-fifths of an acre, on which were set two hundred and twenty-five vines. In the smaller vineyard, only three groups of root stocks were used and in the larger vineyard, four groups. In successive rows were set stocks on their own roots, on roots of St. George (Rupestris du Lot), on Riparia Gloire de Montpellier and on Clevener.

Characteristics of root-stocks.

The St. George was selected as a variety pre-eminently well adapted to sandy, gravelly, rocky soils. It has strong roots which force themselves deeply into even very compact soils and enable it to withstand droughts. It is very vigorous in growth and communicates its strength to its grafts. It roots rapidly in the nursery and unites well when grafted with either Vinifera varieties or American species. In New York it was found to sucker very freely, the principal defect of the stock. The Riparia Gloire, as it is called for short, has small, hard, numerous, much-branched roots, which

feed close to the surface of the ground. It grows best in deep, rich soils which must not be either too wet or too dry. Like St. George, it is vigorous, imparts its vigor to vines worked upon it, and is also specially hardy. It is well adapted for grafting purposes, as it unites readily with our cultivated varieties. Its principal defect is some fastidiousness as to soils. The Clevener stock was selected since it grows on a wide range of soils. It has already been used to some extent as a root-stock in this State. The Riparia Gloire and St. George stocks came from California and were in very poor shape on arrival. They were set in May, 1902, and by the fall of that year, one-fifth of the St. George plants and five-sixths of the Riparia Gloire vines had died, but the vacancies were filled with new stocks of the same varieties. These replanted vines were taken from nursery rows where they had been set after bench-grafting the cions on closely-trimmed root stocks. The Clevener stocks were not set until the spring of 1903. The field grafting upon all these stocks was begun in May, 1903, which was probably not the best time; as subsequent experience has proven that the union is best if the grafting is done when the stock is not in full sap.

Varieties used.

As varieties to be grafted upon these stocks, about twenty kinds of exceptionally good quality were selected, practically all of which had already been grown more or less in the Chautauqua Grape Belt. These varieties, with a brief indication of the reason for their choice, are as follows: Agawam, Barry, Brilliant, Lindley, Mills, and Niagara were selected as varieties which, though admirable in most other respects, are hardly productive enough to be commercially profitable; and in France and in California grafting on other roots has often increased productivity. In other instances, grafting has enabled certain varieties to be grown on soils seemingly not adapted to them and since Campbell Early, Delaware, Herbert, Iona, Lindley, and Worden succeed only when soil conditions are right, it was hoped to find in some of the new root

stocks a medium to increase the range of cultivation of these varieties. If Brilliant, Goff, Vergennes and Winchell could be improved in bunch characteristics, they might become very valuable sorts and grafting has sometimes worked such improvement, so these varieties were included. Jefferson and Niagara are not always hardy under New York conditions and if their growth on other stocks could make them more resistant to cold it would improve their standing as commercial varieties. Delaware was used in the hope that its slow rate of growth might be overcome. Catawba, grown on its own roots, is a little too late to succeed in most seasons in New York, and Brighton deteriorates rapidly after picking. If these qualities could be remedied by grafting, most desirable results would be secured.

Progress of the experiment.

The failure of vines during the first year was an inauspicious beginning and similar misfortunes followed the experiment throughout its progress. During the second year, 1903, seventeen more Riparia Gloire stocks died, nine of St. George, nine of Clevener, and twenty-nine on their own roots, while of the grafts, eight on the Gloire died and forty-eight on the St. George but none on Clevener. During the winter of 1903--04, the weather was very severe and in the spring and summer of the following season many more vines died; of St. George, eighty-five; of Gloire, fifty-six, and of those on their own roots, forty-eight. The effects of this severe winter were remedied as far as possible by setting in new vines, but the consequences of the freeze plainly extended through several subsequent seasons as many of the vines lagged in growth and never reached their normal vigor. As a commercial venture and, as later events proved, as an experimental one, it would have been better to dig the vines up in 1904 and to begin anew. The freeze, however, gives some indication of the relative hardiness of the vines of these varieties on different stocks; as only 36½ per ct. died on St. George roots, while over 44 per ct. were lost on Clevener and about 40 per ct. on Gloire or on their own roots. It is possible that the deep-rooting habit of the St. George stock

enabled it to resist this cold weather a little better than the other stocks.

During 1906 the grape fidia, which had appeared in the vineyard a few years previous, began to affect some of the vines severely and this injury continued to some extent throughout the remaining years of the experiment, although repressive measures were fairly successful in controlling the insect. In 1906, additional vines died; on Gloire stock thirty-four, on St. George twenty-seven, on Clevener thirty-five, and on their own roots nine. These dead vines were, in many cases, weaklings injured by the severe weather of the two winters past. In 1907, the vines appeared to be making good growth and there were fair prospects for a good harvest of grapes, but in August a hailstorm ruined the crop so that the fruit was never picked; and again in 1910 the crop was entirely destroyed by hail.

Grafted vines more productive.

The death of so many vines during early stages of the experiment, severe attacks of fidia during one or two seasons, and the two disastrous hailstorms have made it impossible to secure any satisfactory amount of data upon which to base definite conclusions regarding productivity of the individual varieties. Yet throughout the whole course of the work, observations have shown that grafted vines were fruiting better than vines of the same varieties on their own roots. Not only were more bunches set upon the grafted vines, as shown by actual count, but the bunches and the berries also grew larger, resulting in less unmarketable fruit. Such data as were secured from three fairly satisfactory harvests—those of 1908–09–11—give evidence in the same direction. Computations, based on the actual weight of fruit harvested from each vine, would give an average acre yield of $2\frac{1}{4}$ tons of grapes from varieties on their own roots, 3 tons from those on St. George stock, 3.4 tons from those on the Gloire stock and 3.6 tons from those on Clevener roots. These yields are, of course, small, and perhaps ought not to give any great weight to an experiment which has lasted through eleven years. In reality, during this time only one satisfactory harvest was secured, that of the year 1911; and the figures for

this year alone correspond very closely to the judgment of the observers from general behavior of the vines and might be taken as an index of the trend of the experiment. They point in the same direction as the figures from the averages of the three crops. The yields in this year were, for varieties on their own roots 4.4 tons per acre, on St. George roots 5.4 tons, on Gloire 5.3 tons, and on Clevener 5.6 tons. The data are too few and scattering to attempt comparisons variety by variety either in productivity, resistance to insects or diseases, or except in a general way in adaptability of cions to stocks.

Grafted vines more vigorous.

However, it was very plain to those who studied the vineyard that the grafted vines were more vigorous than those not grafted. In an attempt to bring out this point, the vigor of vines was carefully rated in one season. Early in 1910, when the vineyard had reached bearing age, when insects and fungi were well under control and before the hailstorm of that year ruined the crop, careful estimates gave varieties on their own roots an average rating of 40 per ct. of perfect vigor, those on St. George 63.2 per ct., those on Gloire 65.2 and those on Clevener 67.9 per ct. As already stated, it would be unfair to make strict varietal comparsions in this regard, but the better behavior of nearly all the varieties on all three of the stocks proves these stocks congenial for union with our varieties and speaks in favor of their use in future work along this line. No variety on its own roots reached an average of 70 per ct. of what might be expected, but on Gloire roots, Concord, Herbert, and Lindley reached averages of more than 75 per ct.; on St. George roots, Concord, Herbert, Niagara, and Vergennes all exceeded this average; while on Clevener roots Barry, Brighton, Catawba, Delaware, Lindley, Regal, and Vergennes proved far better than on their own roots.

Resistance to insects and diseases.

While one of the principal objects of the experiment was to test the effect of grafting upon resistance to insects and diseases, the work has really furnished no satisfactory evidence along these lines. The mishaps during the early years of the test made so unequal the numbers of

vines of the same age among the different varieties that it is practically impossible to secure a fair estimate as to the relative damage of insects or diseases upon either roots or vines. When the earlier experiments proved that this vineyard was not likely to be an unqualified success a similar experiment was started elsewhere, it is hoped under more favorable conditions. From this second test it is expected that at least some suggestions of value along the line of insect resistance will be secured.

Some grafted grapes earlier.

Some grapes on grafted vines ripened a few days earlier than those on their own roots. This was true, in particular, as regards those on Gloire and Clevener; but it is not certain that there is a constant difference in the time of ripening between the same varieties on St. George roots and on their own. In fact, some varieties on St. George were retarded in time of maturity. The data relating to time of ripening, however, are not satisfactory, like others in the test; but it is hoped that the second experiment will furnish more definite information.

Conclusions.

Unsatisfactory as it has been, this experiment seems to promise quite a little of value in grape-grafting for New York State. Undoubtedly some of the best varieties of table grapes suitable to the Chautauqua Grape Belt can be improved in some respects by grafting and it is not entirely improbable that even commercial vineyards will show a sufficient increase in productiveness to warrant the adoption of the practice in starting new vineyards. If the method is adopted, however, some of the mistakes in this experiment should be avoided. In the first place, it would have been much better to use bench-grafted vines instead of grafting in the field on growing stocks, as a very large proportion of the plants thus treated died in this experiment; and a considerable portion might do so in any commercial planting. Such vacancies must be filled by bench-grafted material. Bench-grafting in itself gives better results, is much more easily performed and can be kept under closer supervision of an expert than can work done in the

field. If all the vines were bench-grafted originally and grown in the nursery row for a year, careful selection could be made of perfect, vigorous plants, with unions well established, to be set in places where desired with the unions placed at the desired level in the soil and the plants free from undesired suckers from the root stocks or roots from the cions. By this method subsequent vine failures should be very few under ordinarily good conditions. By this means, also, the vineyard area can be held for one year longer for other crops, or for better preparation for vineyard purposes.

In selecting stocks for such work, it is believed that the three used in this experiment should all be given a trial though it may be rather difficult to secure the Clevener stocks necessary, while the St. George and Riparia Gloire stocks can be readily secured from California growers. To these stocks might well be added Riparis Grand Glabre and two hybrids between *Vitis riparia* and *Vitis rupestris* known as 3306 and 3309, which have been found useful in California viticulture.

If a grafted vineyard is established, it will be necessary to give better care to it than the ordinary vineyard receives, in pruning particularly, but to some extent in plowing, tilling, fertilizing and treatment of phylloxera and fidia. The varieties on other roots will require different treatment from the same ones ungrafted. This is by no means a disadvantage, for, probably, of all our horticulturists the vineyardists have become least caretaking. If the grafting in itself did not promise larger yields, its adoption would be of profitable benefit to New York viticulture if it secured to the new vineyards the care grape-growing should receive.

PERIODICALS RECEIVED BY THE STATION.

Acclimitation	Complimentary
Agricultural Epitomist	Complimentary
Agricultural Gazette of New South Wales	Complimentary
Agricultural Journal, China	Complimentary
Agricultural Journal of the Union of South Africa	Complimentary
Agricultural News	Complimentary
Agricultural Students' Gazette	Complimentary
Allegan Gazette	Complimentary
American Agriculturist	Subscription
American Breeders' Magazine	Subscription
American Chemical Journal	Subscription
American Chemical Society, Journal	Subscription
American Cultivator	Complimentary
American Entomological Society, Transactions	Subscription
American Fertilizer	Subscription
American Florist	Subscription
American Grocer	Complimentary
American Hay, Flour and Feed Journal	Complimentary
American Journal of Physiology	Subscription
American Miller	Complimentary
American Naturalist	Subscription
American Philosophical Society, Proceedings	Complimentary
American Poultry Advocate	Complimentary
American Poultry World	Subscription
American Stock Keeper	Complimentary
Analyst	Subscription
Annales de l'Institut Pasteur	Subscription
Annales de la Societe Entomologique de Belgique	Complimentary
Annales Mycologici	Subscription
Annals and Magazine of Natural History	Subscription
Annals of Botany	Subscription
Archiv der Gesammte Physiologie (Pflueger)	Subscription
Archiv fuer Hygiene	Subscription
Association Belge des Chimistes, Bulletin	Complimentary
Berichte der deutschen botanischen Gesellschaft	Subscription
Berichte der deutschen chemischen Gesellschaft	Subscription
Better Fruit	Complimentary
Biedermann's Zentralblatt fuer Agrikultur Chemie	Subscription
Biochemische Zeitschrift	Subscription
Biochemisches Centralblatt	Subscription
Biological Bulletin	Subscription
Biologisches Centralblatt	Subscription
Blooded Stock	Complimentary
Boletim de Agricultura	Complimentary
Boletim do Instituto Agronomico	Complimentary
Boletin de la Sociedad Nacional de Agricultura	Complimentary

Boletin de Ministero de Frumento	Complimentary
Boston Society of Natural History, Proceedings	Complimentary
Botanical Gazette	Subscription
Buffalo Society of Natural Sciences, Bulletin	Complimentary
Bulletin de l'Institut Pasteur	Subscription
Bulletin fuer Angewandte Botanik	Subscription
Caledonia Era	Complimentary
California Academy of Sciences, Proceedings	Complimentary
California Cultivator	Complimentary
California Fruit Grower	Subscription
California University Publications —Agricultural Sciences and Botany	Complimentary
Canadian Entomologist	Subscription
Canadian Horticulturist	Complimentary
Centralblatt fuer Bakteriologie, etc	Subscription
Chemical Abstracts	Subscription
Chemical Society, Journal	Subscription
Chemisches Centralblatt	Subscription
Chicago Daily Farmers' and Drovers' Journal	Complimentary
Chicago Dairy Produce	Complimentary
Cincinnati Society of Natural History, Journal	Complimentary
Cold Storage and Ice Trades Review	Complimentary
Colman's Rural World	Complimentary
Colonial Dairy Produce Report	Complimentary
Columbus Horticultural Society Journal	Complimentary
Commercial Poultry	Complimentary
Country Gentleman	Subscription
Country Life in America	Subscription
Country World	Complimentary
Criador Paulista	Complimentary
Dairy and Produce Review	Complimentary
Denver Field and Farm	Complimentary
Deutsche Entomologische Zeitschrift	Complimentary
Deutschlands Obstsorten	Subscription
Dry Farming	Subscription
Elgin Dairy Report	Complimentary
Elisha Mitchell Scientific Society, Journal	Complimentary
Entomological News	Subscription
Entomological Society of America, Annals	Subscription
Entomological Society of Washington, Proceedings	Subscription
Entomologist	Subscription
Entomologists' Record	Subscription
Farm and Fireside	Complimentary
Farm and Live Stock Journal	Complimentary
Farm and Orchard	Complimentary
Farm and Stock	Complimentary
Farm Economies	Complimentary
Farm Journal	Complimentary

Farm Life	Complimentary
Farm News	Complimentary
Farm Poultry	Complimentary
Farm, Stock and Home	Complimentary
Farm Stock Success	Complimentary
Farmers' Advocate	Complimentary
Farmers' Digest	Complimentary
Farmers' Guide	Complimentary
Farmers' Voice	Complimentary
Farmer's Wife	Complimentary
Feather	Subscription
Feathered World	Subscription
Florists' Exchange	Subscription
Flour and Feed	Complimentary
Fruit Grower	Complimentary
Garden	Subscription
Gardeners' Chronicle	Subscription
Gardeners' Chronicle of America	Complimentary
Gardening	Subscription
Gartenwelt	Subscription
Gas and Oil Power	Complimentary
Gleanings in Bee Culture	Complimentary
Grape Belt, The	Complimentary
Green's Fruit Grower	Complimentary
Hartwick Seminary Monthly	Complimentary
Hawaiian Forester and Agriculturist	Complimentary
Hedwigia	Subscription
Herd Register	Complimentary
Herkimer County News	Complimentary
Hoard's Dairyman	Complimentary
Holstein-Friesian Register	Complimentary
Holstein-Friesian World	Complimentary
Homestead	Complimentary
Hygienische Rundschau	Subscription
Indiana Farmer	Complimentary
Insect World (Japanese)	Complimentary
Internationale Mitteilungen fuer Bodenkunde	Subscription
Ithaca Chronicle	Complimentary
Jahresbericht der Agrikultur-Chemie	Subscription
Jahresbericht Garungs-Organismen	Subscription
Jahresbericht der Nahrungs- und Genussmittel	Subscription
Jahresbericht Pflanzenkrankheiten	Subscription
Jahresbericht der Tier-Chemie	Subscription
Jahresheft Schlesische Insektenkunde	Complimentary
Jersey Bulletin	Complimentary
Journal de Botanique	Subscription
Journal fuer Landwirtschaft	Subscription
Journal of Agricultural Science	Subscription

Journal of Agriculture, Victoria	Complimentary
Journal of Biological Chemistry	Subscription
Journal of Board of Agriculture (English)	Complimentary
Journal of the College of Agriculture, Tokyo	Complimentary
Journal of the Dept. of Agriculture of South Australia	Complimentary
Journal of the Dept. of Agriculture of Victoria	Complimentary
Journal of the New Zealand Department of Agriculture	Complimentary
Journal of Economic Biology	Subscription
Journal of Experimental Medicine	Subscription
Journal of Experimental Zoology	Subscription
Journal of Genetics	Subscription
Journal of Home Economics	Subscription
Journal of Industrial and Engineering Chemistry	Subscription
Journal of Physiology	Subscription
Just's Botanischer Jahresbericht	Subscription
Kimball's Dairy Farmer	Complimentary
Königleichen Bayerische Akademie der Wissenschaften: Sitzungsberichte der Math.— Phys. Classe	Subscription
Land, The	Complimentary
Lanswirtschaft-Historische Blätter	Complimentary
Landwirtschaftliche Jahrbucher	Subscription
Landwirtschaftlicher Jahrbuch der Schweiz	Subscription
Landwirtschaftlichen Versuchs-Stationen	Subscription
Live Stock and Dairy Journal	Complimentary
Live Stock Report	Complimentary
Long Island Democrat	Complimentary
Maandblad der Nederlandsche Pomologische Vereeniging	Complimentary
Market Fruit-Growers' Journal	Complimentary
Marlboro Record	Complimentary
Memoirs of the Department of Agriculture in India	Complimentary
Metropolitan and Rural Home	Complimentary
Michigan Farmer	Complimentary
Milchwirtschaftliches Zentralblatt	Subscription
Minnesota and Dakota Farmer	Complimentary
Mirror and Farmer	Complimentary
Monthly Bulletin of the N. Y. State Department of Health	Complimentary
Monthly Weather Review	Complimentary
Mycologia	Subscription
National Nurseryman	Complimentary
National Farmer and Stock Grower	Complimentary
National Stockman and Farmer	Complimentary
Naturaliste Canadienne	Complimentary
Nebraska Farmer	Complimentary
New Education	Complimentary
New England Farmer	Complimentary
New York Academy of Science, Annals and Transactions	Subscription
New York Botanical Garden, Bulletin	Complimentary
New York Entomological Society, Journal	Subscription

New York Farmer	Complimentary
New York Fruit and Produce News	Complimentary
New Zealand Dairyman	Complimentary
North American Horticulturist	Complimentary
Northwest Pacific Farmer	Complimentary
Nut Grower	Complimentary
Ohio Farmer	Complimentary
Ohio Naturalist	Subscription
Oklahoma Farm Journal	Complimentary
Pacific Coast Fanciers' Monthly	Subscription
Pacific Northwest	Complimentary
Pacific Fruit World	Complimentary
Parasitology	Subscription
Pennsylvania Farmer	Complimentary
Photo-Miniature	Subscription
Phytopathology	Subscription
Parasitology	Subscription
Popular Agriculturist	Complimentary
Poultry	Complimentary
Poultry Herald	Subscription
Poultry Husbandry	Complimentary
Poultry Item	Complimentary
Poultry Industry	Complimentary
Poultry Keeper	Complimentary
Poultry Monthly	Complimentary
Power and Engineer	Subscription
Practical Dairyman	Complimentary
Practical Farmer	Complimentary
Practical Fruit Grower	Complimentary
Praktische Blaetter fuer Pflanzenschutz	Subscription
Progressive Farmer	Complimentary
Profitable Farming	Complimentary
Psyche	Subscription
Rabenhorst's Kryptogamen-Flora	Subscription
Reliable Poultry Journal	Subscription
Republic	Complimentary
Revista Industrial y Agricola de Tucuman	Complimentary
Revue Generale de Botanique	Subscription
Revue Generale du Lait	Subscription
Revue Horticole	Subscription
Riqueza Agricola	Complimentary
Rochester Academy of Science, Proceedings	Complimentary
Royal Agricultural Society, Journal	Subscription
Royal Botanic Gardens, Edinburgh, Notes	Complimentary
Royal Horticultural Society, Journal	Complimentary
Rural Life	Complimentary
Rural New Yorker	Subscription
Salt Lake Herald	Complimentary

Saint Louis Academy of Science, Transactions	Complimentary
Sanitary Inspector	Complimentary
Science	Subscription
Scientific American	Subscription
Scientific Roll, Bacteria	Subscription
Skaneateles Democrat	Complimentary
Smallholder, The	Complimentary
Societe Entomologique de Belgique, Annales	Complimentary
Societe Entomologique de France, Bulletin	Complimentary
Societe Mycologique de France, Bulletin	Subscription
Southern Planter	Complimentary
Southern Tobacconist and Modern Farmer	Complimentary
Southern Farm Magazine	Complimentary
Southwestern Farmer and American Horticulturist	Complimentary
Southwestern Farmer and Breeder	Complimentary
Southwestern Stockman, Farmer and Feeder	Complimentary
Standard and Poultry World	Complimentary
Station, Farm and Dairy	Complimentary
Stazione Sperimentale Agrarie Italiane	Complimentary
Student Farmer, The	Complimentary
Successful Farming	Complimentary
Suffolk Herald	Complimentary
Texas Stockman and Farmer	Complimentary
Torrey Botanical Club, Bulletins and Memoirs	Subscription
Transvaal Agricultural Journal	Complimentary
Trucker and Farmer	Complimentary
Utica Semi-Weekly Press	Complimentary
Wallace's Farmer	Complimentary
Weekly Enquirer (Cincinnati)	Complimentary
West Indian Bulletin	Complimentary
West Virginia Farm Review	Complimentary
Western Fruit-Grower	Complimentary
Western Plowman	Complimentary
Wisconsin Natural History Society, Bulletin	Complimentary
Zeitschrift fuer Analytische Chemie	Subscription
Zeitschrift fuer Biologie	Subscription
Zeitschrift fuer Botanik	Subscription
Zeitschrift fuer Entomologie	Complimentary
Zeitschrift fuer Hygiene und Infektionskrankheiten	Subscription
Zeitschrift fuer Induktive Abstammungs- und Vererbungslehre	Subscription
Zeitschrift fuer Pflanzenkrankheiten	Subscription
Zeitschrift fuer Physiologische Chemie	Subscription
Zeitschrift fuer Wissenschaftliche Insektenbiologie	Subscription
Zentralblatt fuer Biochemie und Biophysik	Subscription
Zoological Record	Subscription
Zoologischer Anzeiger	Subscription

METEOROLOGICAL RECORDS FOR 1912.

METEOROLOGICAL RECORDS FOR 1912.

READING OF THE STANDARD AIR THERMOMETER.

DATE.	January.			February.			March.		
	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.
1	28.	31.	28.	13.	25.	28.	10.	20.	18.
2	22.	30.	32.	24.	28.	24.	10.	17.	14.
3	22.	25.	21.	5.	13.	10.	7.	17.	12.
4	15.	29.	27.	7.	7.	6.	—1.	18.	16.
5	5.	8.5	6.	3.	10.	11.	7.	17.	15.
6	0.	6.	2.	12.	20.	20.	6.	28.	28.
7	4.	12.	6.	23.	24.	22.	26.	38.	39.
8	5.	12.	21.	17.	16.	12.	31.	40.	37.
9	14.	12.	9.	3.	10.	5.	27.	24.	24.
10	5.	11.	6.	—10.	—4.	—3.	15.	23.	23.
11	8.	14.	8.	—5.	8.	6.	15.	31.	31.
12	—2.	4.	—1.	3.	19.	15.	30.	33.	33.5
13	—5.	5.	0.	7.	19.	21.	26.	29.	33.
14	4.	14.	17.	15.	31.	31.	22.	38.	37.
15	20.	22.	11.	22.	27.	30.	35.	40.	39.
16	3.	7.	7.	12.	22.	33.5	24.	33.	36.
17	13.	16.	20.	30.	35.	34.	35.	44.	48.
18	31.5	42.	41.	23.	37.	40.	39.	43.	42.
19	30.	24.	13.	36.	41.	39.	32.	52.	53.
20	6.	19.	21.	33.	34.	30.	31.	30.	24.
21	20.	23.	21.	19.	20.	24.	16.	17.	19.
22	23.	24.	22.	19.	16.	15.	15.	27.	26.
23	26.	34.	28.	14.	30.	31.	10.	30.	34.
24	21.	20.	15.	37.	48.	42.	31.	37.	31.
25	7.	14.	9.	35.	41.	37.	19.	24.	23.
26	—4.	14.	12.	23.	27.	36.	15.	32.	38.
27	8.	12.	10.	27.	20.	20.	35.	41.	41.
28	10.	16.	15.5	17.	25.	22.	33.	44.	46.
29	23.	27.	31.	13.	23.	21.	39.	42.	41.
30	27.	25.	25.	......	......	......	27.	35.	38.
31	21.	22.	18.	......	......	......	34.	56.	51.
Averages	13.2	18.5	16.2	17.	23.3	22.9	22.6	32.3	32.

DATE.	April.			May.			June.		
	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.
1	27.	35.	34.	47.	62.	60.	64.	79.	81.
2	29.	30.	29.	47.	62.	61.	65.	82.	69.
3	26.	27.	26.	51.	63.	62.	64.	75.	80.
4	25.	35.	38.	52.	66.	68.	66.	66.	72.
5	45.	62.	64.	53.	57.	56.	52.	62.	67.
6	57.	72.	74.	54.	68.	72.	57.	64.	65.
7	57.	57.	36.	57.	60.	68.	52.	57.	60.
8	24.	29.	33.	57.	61.	66.	51.	64.	69.
9	30.	36.	46.	57.	51.	52.	57.	65.	67.
10	31.	32.	40.	57.	67.	69.	58.	72.	68.
11	36.	37.	43.	54.	71.	73.	65.	78.	76.
12	32.	39.	42.	60.	70.	68.	67.	71.	67.
13	44.	45.	49.	59.	57.	47.	51.	61.	65.
14	44.	56.	56.	45.	49.	52.	55.	68.	72.
15	55.	70.	65.	50.	60.	64.	55.	61.	61.
16	58.	67.	55.	52.	57.	55.	70.	75.	79.
17	37.	46.	44.	54.	62.	55.	59.	66.	75.
18	49.	58.	50.	55.	68.	72.	59.	67.	61.
19	38.	40.	45.	51.	51.	54.	60.	66.	69.
20	36.	47.	55.	49.	60.	63.	60.	72.	74.
21	43.	61.	65.	59.	59.	48.	61.	65.	63.
22	54.	61.	55.	50.	69.	76.	56.	71.	75.
23	32.	43.	49.	59.	80.	79.	65.	75.	77.
24	41.	57.	55.	66.	80.	77.	64.	80.	80.
25	44.	56.	59.	55.	67.	68.	67.	83.	74.
26	48.	59.	54.	59.	71.	75.	70.	69.	76.
27	58.	50.	47.	58.	75.	79.	62.	75.	79.
28	35.	47.	45.	69.	86.	81.	68.	84.	83.
29	37.	41.	41.	68.	78.	57.	74.	85.	81.
30	41.	55.	57.	50.	50.	48.	57.	68.	69.
31	......	......	......	50.	66.	71.	......	......	......
Averages	40.4	48.3	48.4	55.	64.9	64.4	61.	70.9	71.8

READING OF THE STANDARD AIR THERMOMETER — (*Concluded*).

DATE.	July.			August.			September.			October.			November.			December.		
	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.	7 A. M.	12 M.	5 P. M.
1	61.	74.	77.	62.	69.	66.	61.	74.	59.	48.	49.	49.	50.	60.	45.	26.	35.	38.
2	67.	83.	85.	64.	70.	60.	62.	67.	79.	46.	59.	62.	32.	36.	30.	45.	47.	50.
3	72.	88.	85.	56.	65.	64.	68.	80.	78.	54.	70.	64.	30.	37.	36.	34.	40.	34.
4	76.	85.	69.	57.	63.	64.	65.	78.	78.	61.	70.	67.	30.	51.	48.	37.	44.	42.
5	75.	86.	87.	57.	70.	70.	71.	73.	80.	55.	71.	70.	53.	61.	53.	33.	44.	47.
6	78.	89.	91.	57.	72.	72.	72.	79.	80.	53.	72.	68.	51.	67.	64.	50.	64.	41.
7	77.	88.	92.	59.	73.	78.	75.	82.	78.	52.	56.	53.	57.	58.	48.	32.	33.	31.
8	77.	89.	88.	65.	71.	73.	65.	79.	80.	38.	53.	53.	38.	45.	44.	32.	41.	26.
9	77.	86.	84.	70.	73.	74.	65.	82.	78.	50.	56.	57.	39.	42.	40.	17.	26.	27.
10	76.	91.	77.	71.	76.	73.	66.	83.	82.	54.	57.	56.	37.	41.	45.	29.	47.	45.
11	72.	78.	75.	66.	77.	73.	72.	68.	67.	55.	67.	65.	43.	60.	60.	35.	34.	33.
12	71.	80.	76.	68.	79.	79.	54.	66.	70.	68.	76.	59.	61.	60.	54.	12.	20.	17.
13	71.	86.	86.	69.	79.	84.	52.	72.	72.	51.	58.	56.	46.	60.	56.	15.	24.	25.
14	75.	80.	87.	74.	82.	83.	65.	74.	76.	45.	60.	56.	47.	48.	40.	34.	38.	33.
15	77.	92.	87.	64.	75.	70.	68.	77.	77.	51.	52.	45.	37.	37.	35.	33.	43.	43.
16	60.	69.	71.	60.	67.	65.	58.	58.	59.	33.	51.	51.	32.	35.	33.	36.	37.	33.
17	69.	79.	77.	53.	70.	68.	48.	65.	66.	35.	66.	58.	36.	37.	36.	27.	37.	41.
18	71.	82.	83.	66.	74.	75.	62.	74.	42.	46.	68.	66.	32.	35.	33.	36.	44.	42.
19	60.	66.	66.	65.	67.	67.	64.	72.	68.	61.	61.	54.	31.	51.	47.	35.	32.	30.
20	62.	72.	72.	64.	74.	72.	57.	65.	65.	42.	56.	55.	38.	54.	47.	29.	29.	31.
21	60.	69.	72.	62.	75.	71.	52.	56.	65.	43.	61.	58.	52.	64.	55.	26.	25.	22.
22	62.	68.	71.	62.	79.	78.	59.	67.	65.	53.	63.	63.	38.	53.	46.	26.	31.	33.
23	60.	70.	69.	61.	71.	63.	57.	60.	60.	53.	51.	48.	33.	47.	45.	23.	29.	26.
24	60.	70.	77.	57.	76.	75.	57.	62.	60.	41.	43.	41.	38.	33.	33.	28.	31.	33.
25	67.	77.	76.	75.	82.	78.	56.	65.	60.	44.	49.	47.	32.	30.	31.	29.	38.	37.
26	62.	74.	76.	70.	79.	84.	60.	66.	60.	46.	46.	45.	33.	36.	35.	28.	41.	37.
27	61.	69.	73.	57.	63.	63.	49.	55.	54.	40.	57.	52.	32.	34.	31.	35.	33.	31.
28	62.	80.	74.	55.	61.	58.	46.	58.	60.	42.	46.	44.	22.	30.	28.	27.	28.	32.
29	68.	69.	74.	57.	67.	65.	49.	47.	45.	44.	62.	61.	21.	34.	37.	26.	43.	39.
30	69.	73.	69.	50.	62.	62.	39.	54.	47.	56.	49.	44.	35.	40.	36.	39.	36.	37.
31	56.	65.	68.	53.	54.	57.	......	......	......	42.	51.	45.	......	......	......	34.	44.	41.
Averages	68.1	78.3	77.9	62.1	71.5	70.5	59.8	68.6	67.	48.5	58.3	55.2	38.5	45.8	42.4	30.6	36.7	34.7

READING OF MAXIMUM AND MINIMUM THERMOMETERS FOR 1912.

DATE.	JANUARY.		FEBRUARY.		MARCH.		APRIL.		MAY.		JUNE.	
	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.
1	40.	27.	30.	12.	21.	10.	51.	25.	65.	35.	89.	52.
2	34.	21.	29.	10.	19.	8.	34.	28.	60.	40.	84.	64.
3	33.	20.	24.	5.	19.	5.5	30.	23.	64.	38.	84.	61.
4	30.	10.	10.	5.	24.	—1.	41.	19.	65.	39.	86.	57.
5	23.	5.	14.	3.	20.	6.	68.	35.	60.	40.	72.	45.
6	7.	—1.	23.	10.	30.	3.	78.	47.	75.	49.	71.	44.
7	13.	—2.	25.	19.	43.	25.	73.	35.	71.	54.	67.	42.
8	21.	—2.	23.	11.	40.	28.	37.	22.	76.	53.	69.	40.
9	38.	1.	17.	—1.	37.	13.	50.	26.	60.	47.	70.	43.
10	11.	3.	5.	—10	25.	12.	48.	30.	70.	46.	70.	46.
11	15.	4.	10.	—9.	34.	13.	43.	34.	79.	47.	79.	46.
12	7.	—3.	23.	2.	35.	28.	43.	29.	76.	55.	71.	46.
13	8.	—7.	25.	1.	34.	25.	55.	31.	70.	46.	74.	44.
14	17.	—12.	35.	4.	41.	18.	58.	42.	55.	34.	72.	41.
15	22.	11.	34.	20.	41.	32.	76.	50.	65.	38.	74.	54.
16	11.	1.	40.	10.	44.	23.	71.	50.	64.	49.	80.	59.
17	20.	6.	37.	29.	51.	22.	55.	34.	64.	46.	75.	56.
18	44.	19.	41.	20.	48.	38.	65.	40.	73.	49.	75.	47.
19	42.	13.	42.	35.	55.	29.	50.	36.	71.	49.	76.	45.
20	22.	5.	39.	30.	55.	23.	61.	30.	75.	45.	76.	54.
21	25.	18.	39.	17.	24.	15.	66.	30.	71.	46.	76.	54.
22	25.	18.	37.	15.	30.	14.	66.	49.	78.	46.	76.	51.
23	34.	21.	34.	15.	34.	7.	66.	30.	85.	56.	80.	48.
24	29.	15.	48.	28.5	38.	30.	61.	34.	88.	66.	83.	56.
25	15.	6.	44.	33.	32.	17.	60.	35.	84.	52.	86.	56.
26	17.	—5.	37.	22.	38.	7.5	63.	39.	76.	43.	78.	56.
27	14.	7.	38.	19.	44.	31.	61.	46.	81.	44.	81.	46.
28	19.	7.	25.	16.	49.	25.	48.	29.	87.	60.	88.	61.
29	31.	14.	23.	12.	46.	36.	45.	35.	59.	56.	88.	64.
30	33.	25.	......	......	42.	23.	61.	34.	57.	46.	81.	50.
31	25.	18.	......	......	62.	27.	......	......	72.	46.	......	......
Averages	23.4	8.5	29.3	13.9	37.3	19.2	56.1	34.2	70.8	47.1	77.7	50.9

READING OF MAXIMUM AND MINIMUM THERMOMETERS FOR 1912 — (*Concluded*).

DATE.	JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.		DECEMBER.	
	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.	5 P. M. Max.	5 P. M. Min.
1	79.	41.	86.	48.	85.	56.	58.	44.	65.	43.	39.	23.
2	87.	52.	74.	57.	86.	59.	65.	36.	45.	30.	52.	34.
3	90.	63.	68.	53.	90.	65.	77.	46.	39.	28.	50.	33.
4	89.	65.	80.	49.	93.	59.	79.	56.	55.	27.	46.	30.
5	90.	65.	71.	53.	90.	60.	82.	46.	63.	44.	51.	28.
6	92.	67.	85.	50.	95.	67.	83.	47.	69.	45.	65.	41.
7	95.	66.	80.	57.	89.	65.	72.	51.	69.	48.	41.	30.
8	95.	68.	87.	62.	93.	56.	58.	37.	49.	37.	43.	26.
9	90.	69.	88.	65.	84.	59.	60.	45.	45.	37.	27.	12.
10	95.	67.	85.	67.	95.	59.	61.	52.	52.	34.	48.	24.
11	83.	68.	78.	59.	89.	68.	74.	51.	68.	40.	45.	33.
12	84.	68.	79.	63.	90.	44.	78.	57.	64.	52.	33.	12.
13	87.	61.	91.	64.	91.	51.	60.	43.	63.	43.	26.	13.
14	88.	70.	92.	67.	88.	60.	63.	40.	56.	40.	41.	25.
15	89.	69.	87.	61.	90.	65.	56.	40.	41.	33.	46.	37.
16	87.	59.	80.	52.	80.	55.	56.	31.	40.	30.	44.	33.
17	83.	56.	71.	44.	72.	44.	69.	33.	42.	31.	41.	25.
18	87.	67.	80.	54.	75.	43.	73.	42.	37.	31.	48.	34.
19	89.	55.	82.	63.	80.	61.	66.	54.	54.	27.	44.	30.
20	88.	46.	79.	62.	82.	51.	61.	40.	60.	36.	31.	27.
21	90.	59.	85.	57.	75.	50.	64.	36.	66.	38.	31.	22.
22	72.	59.	85.	57.	75.	51.	66.	49.	56.	35.	33.	18.
23	75.	51.	84.	60.	75.	51.	64.	48.	51.	31.	33.	19.
24	87.	54.	76.	51.	71.	52.	47.	39.	45.	32.	36.	26.
25	84.	50.	84.	66.	66.	62.	51.	40.	36.	29.	42.	22.
26	90.	57.	84.	65.	80.	60.	48.	44.	37.	30.	44.	27.
27	89.	58.	85.	55.	70.	57.	59.	33.	36.	30.	37.	31.
28	85.	54.	70.	47.	62.	60.	53.	38.	33.	20.	32.	21.
29	80.	53.	69.	57.	75.	44.	66.	35.	37.	21.	43.	20.
30	84.	59.	78.	45.	59.	34.	62.	44.	41.	34.	42.	35.
31	89.	54.	75.	48.	......	......	55.	37.	......	......	49.	31.
Averages	86.8	59.7	80.6	56.7	81.5	55.3	64.	43.	50.5	34.5	41.4	26.5

SUMMARY OF AVERAGES OF MAXIMUM, MINIMUM AND STANDARD AIR THERMOMETERS FOR 1912.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum	23.4	29.3	37.3	56.1	70.8	77.7	86.8	80.6	81.5	64.1	50.5	41.4
Minimum	8.5	13.9	19.2	34.2	47.1	50.9	59.7	56.7	55.3	43.	34.5	26.5
Standard 7 A. M.	13.2	17.	22.6	40.4	55.	70.9	68.1	62.1	59.8	48.5	38.5	30.6
Standard 12 M.	18.5	23.3	32.3	48.3	64.9	77.7	78.3	71.5	68.6	58.3	45.8	36.7
Standard 5 P. M.	16.2	22.9	32.	48.4	64.4	50.9	77.9	70.5	67.	55.2	42.4	34.7

MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1912 INCLUSIVE.

(Highest and Lowest Record for Each Month in Heavy Type.)

	JANUARY.				FEBRUARY.				MARCH.				APRIL.			
	MAX.		MIN.		MAX.		MIN.		MAX.		MIN.		MAX.		MIN.	
	Date.	Temp.	Date.	Temp.	Date	Temp.	Date	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
1883	18.	44.	11.	—9.	17.	48.	24.	—2.	19.	61.	9.	2.	16.	75.	1.	19.
1884	14.	42.	26.	—13.	7.	55.	29.	—3.	30.	54.	1.	—4.	28.	74.	1.	23.
1885	1.	61.	29.	—6.	10.	38.	11.	—11.5	28.	48.	13.	—11.	24.	84.5	10.	20.5
1886	5.	52.5	13.	**—18.7**	9.	50.	27.	—11.	16.	58.	2.	—2.5	24.	80.5	4.	22.
1887	24.	50.7	19.	—8.	9.	54.2	27.	—4.	3.	51.7	1 & 5	8.7	11.	75.7	1.	17.2
1888	2.	43.2	23.	—6.	21.	49.	10.	—7.	28.	57.	13.	0.	29.	82.5	8.	19.
1889	18.	55.	20.	5.	23.	42.	4 & 24	—7.	28.	61.8	30.	18.5	20.	84.	1.	26.
1890	6.	67.	29.	9.	5.	**64.5**	11&21	9.5	13.	62.	8.	2.	13.	78.8	1 & 19	23.
1891	3.	46.	17.	4.	26.	56.8	15.	2.5	12.	57.	2.	4.5	28.	81.4	7.	21.
1892	3.	48.	10.	—5.	15.	44.	6.	2.8	27.	52.2	4.	6.	6.	78.	17.	25.5
1893	29.	46.	11.	—6.	15.	47.4	5.	—1.	24.	54.	5.	9.	13.	75.3	26.2	25.
1894	5.	59.	13.	11.	20.	47.6	27.	—8.5	18.	73.	26.	15.	21.	71.3	2.	20.
1895*	7.	45.	19.	4.	25.	46.	8.	—14.	25.	52.	5 & 16	12.	30.	80.	3.	28.
1896	30.	44.	6.	—16.5	29.	49.	17.	**—21.**	31.	56.5	24.	—2.	17.	87.	4 & 5	19.
1897	5.	58.	20.	—3.5	18.	49.5	1 & 27	5.5	21.	64.	1.	—1.	26.	82.	20.	19.
1898	13.	57.	30&31	—4.	12.	56.5	2 & 3	—2.	11.	†65.	2.	17.5	14&18	69.	69.	18.
1899	5.	59.	12.	—4.	21.	52.5	11.	—8.	73.	63.	21.	13.	30.	82.	3.	23.
1900	23.	56.	1.	2.	14.	57.	27.	0.	10.	46.	12.	—3.	30.	‡73.5	9.	g22.
1901	16.	48.	20.	—2.	16.	36.	24.	—2.5	24.	67.	6.	—1.	28.	78.	12.	28.
1902	3.	44.	28.	2.	28.	52.	6.	—3.	12.	66.5	19.	14.	22.	87.	5.	25.
1903	3.	48.	9.	—2.	28.	62.5	18.	—4.	19.	78.5	1 & 2	19.	30.	86.	5.	21.
1904	23.	48.	19.	—14.	7.	58.	16.	18.	26.	58.	4.	8.	24.	67.5	14.	16.
1905	1.	49.	26.	—2.	20.	45.	5 & 14	—6.	29.	82.	5.	1.	27&28	75.	16.	23.
1906	21.	**71.**	9.	4.	24.	64.	6 & 7	—7.	27.	51.	25.	2.	19.	74.	2.	25.
1907	6.	53.	24.	—18.	2.	47.	12.	—4.	29.	83.	7.	—1.	29.	73.	2.	19.
1908	22.	45.	31.	—9.	15.	53.	2 & 5	—14.	28.	73.	1.	8.	27.	78.	4.	18.
1909	24.	64.	19.	—7.	5.	52.	1.	—1.	10.	52.	5.	5.	19.	75.	11.	12.
1910	2 & 22	45.	5.	—8.	16.	49.	7.	—3.	24.	82.	14&18	17.	4.	84.	7.	27.
1911	27&30	48.	5.	—1.	17.	52.	22.	4.	27.	60.	16.	—1.	29.	80.	3.	18.
1912	18.	44.	14.	—12.	24.	48.	10.	—10.	31.	62.	4.	—1.	6.	78.	4.	19.

* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.
† Maximum for first eleven days only. Record incomplete.
‡ Thermometers broken. Record not taken from April 19th to 24th inclusive.

MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1912 INCLUSIVE — (*Continued.*)

(Highest and Lowest Record for Each Month in Heavy Type.)

	May.				June.				July.				August.			
	Max.		Min.		Max.		Min.		Max.		Min.		Max.		Min.	
	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
1883	11.	87.	1 & 14	31.	7.	86.5	2.	42.	5.	89.	1.	46.	23.	92.	15.	46.
1884	24.	88.	30.	32.	25.	90.	15.	41.	2.	87.5	15.	50.	20.	95.	25.	44.
1885	18.	81.7	3.	27.5	14.	86.5	23.	41.5	18.	90.5	12.	46.5	1.	89.	28.	45.
1886	23.	79.5	17&18	37.2	14.	86.2	1.	42.2	7.	95.	1.	45.2	30.	91.5	6.	47.7
1887	23.	88.2	14.	37.5	17.	89.2	15.	47.7	3.	95.5	11.	58.7	3.	88.5	8.	46.
1888	13.	79.8	3.	29.	23.	94.1	4.	40.	5.	89.8	16.	47.	9.	92.6	23.	48.3
1889	18.	91.8	29.	32.	22.	85.	5.	46.	11.	90.7	6.	50.5	31.	86.7	16&17	50.3
1890	4.	80.7	2.	30.	30.	85.6	8	44.8	9.	94.5	24.	46.5	4.	96.2	24.	46.0
1891	11.	85.5	4.	29.5	16.	95.	6.	40.	14.	92.	31.	46.	12.	92.	29.	46.5
1892	31.	78.	9.	34.2	14.	92.	11.	45.8	29.	96.3	2.	46.4	10.	95.5	28.	49.
1893	25.	88.	9.	35.	21.	94.	1.	44.	26.	95.5	24.	48.4	11.	94.5	13.	49.
1894	2.	85.4	14.	32.6	23.	91.6	6.	39.	21.	97.	10.	49.6	25.	93.	27.	45.3
1895*	31.	**92.**	13&21	36.	3.	**96.**	7.	54.	8.	94.	11.	52.	11.	88.	22.	44.
1896	11.	87.5	7 & 20	40.	21.	89.	3.	41.	3.	94.	18.	49.	6 & 7	96.	29.	44.
1897	24.	80.	8.	32.5	24&25	87.5	2.	42.	11.	97.	15.	57.	15.	87.5	21.	46.
1898	29.	79.	6.	34.	9.	90.	16.	40.	4.	96.5	12.	**40.**	24.	90.5	28.	47.
1899	2.	87.5	15.	32.5	6 & 24	93.	11.	41.5	4.	97.5	1.	50.	20.	97.5	15.	44.5
1900	15&16	88.5	7.	27.	25.	93.	10.	45.	17.	96.	1.	50.	11.	97.	2.	51.
1901	23.	78.	16.	36.	27, 28 & 29	95.5	2.	42.	1.	97.5	20.	54.5	22.	90.	5.	52.
1902	22.	90.	11.	26.	3.	85.	6.	38.	14&27	90.	1.	53.	31.	90.	13.	47.
1903	19.	89.	2.	24.	30.	86.5	1.	39.	9.	94.	15.	50.	18.	85.5	8 & 14	45.
1904	25.	88.	12.	31.5	5–24 & 25.	89.	12&17	45.	19.	93.	3.	49.	25.	89.5	19.	45.
1905	3.	82.	2.	29.5	19.	90.	1.	40.	18.	92.	22.	48.5	10.	93.	27.	**41.**
1906	24.	88.5	11&21	30.	8.	92.	12.	**37.**	20–22 & 23	89.	25.	50.	5.	93.	16.	47.
1907	14.	85.	2–11 & 12	28.	18.	94.	3.	41.	16.	90.	4.	46.	12.	96.5	19.	41.5
1908	29.	90.	1–4&5	31.	19.	92.	12.	43.	6–11 & 30	94.	9.	52.	4.	95.	25.	46.
1909	31.	78.	2 & 3	33.	28.	90.	8.	43.	15.	92.	4.	42.	8.	98.	31.	42.
1910	20.	79.	16.	31.5	22.	89.9	4.	36.	9.	96.5	5.	50.	3 & 15	90.	27.	44.
1911	22.	97.	3.	27.	11.	90.5	17.	46.	5.	**105.0**	25–26 & 27	50.	8.	94.5	30.	47.
1912	24.	88.	14.	34.	1.	89.	8.	40.	8 & 10	95.	1.	41.	14.	92.	17.	44.

* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.

MONTHLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1912 INCLUSIVE — (*Concluded*).

(Highest and Lowest Record for each Month in Heavy Type.)

	September.				October.				November.				December.			
	Max.		Min.		Max.		Min.		Max.		Min.		Max.		Min.	
	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
1883	17.	80.	11.	37.	11.	78.	17&18	25.	22.	70.	17.	13.	9 & 14	56.	23.	—7.5
1884	5.	94.	14.	36.	5.	84.2	27.	23.	11.	62.	25.	15.	31.	55.5	20.	**—15.5**
1885	27.	83.7	24.	40.	1.	79.	31.	25.	8 & 13	68.	28.	18.	24.	53.	9.	4.
1886	11.	89.5	22.	49.	10.	76.7	17.	27.5	3.	68.2	28.	17.	11 &25	46.	6.	—6.
1887	22.	81.7	27.	37.2	9.	78.5	31.	**21.2**	28.	68.	30.	15.	12.	54.7	2.	—3.
1888	1 & 10	83.	7.	40.	6.	62.7	22.	29.	1 & 3	**73.**	23.	**8.**	27.	53.	22.	4.
1889	4.	84.	22 & 23 &29	40.	2.	68.7	24.	21.2	4.	61.7	17.	17.8	25.	60.5	4 & 5	8.
1890	8.	83.6	25.	35.5	5.	69.8	31.	32.	8.	65.4	28.	17.	1.	46.2	20.	3.
1891	26.	92.8	30.	43.	4.	89.4	12 &25	27.	1.	68.	29.	12.	5.	57.7	18.	7.
1892	26.	88.	20.	39.	1.	82.	2.	33.1	19.	60.	24.	18.	9.	49.2	27.	—3.7
1893	5.	80.	26.	37.4	13.	76.	31.	25.	3.	62.	27.	19.	26.	62.	14.	1.5
1894	4.	90.	26.	33.	1.	76.5	15.	33.	3.	65.	29.	12.	17.	59.	29.	—0.2
1895*	4.	94.	15 &30	42.	2.	72.	30.	28.	7.	68.	21.	19.	20 &21	62.	13.	—2.
1896	12.	95.	23.	36.	30.	77.5	10 &19	29.	19.	70.	21.	19.5	14.	58.	28.	2.
1897	11.	**98.**	21.	37.5	16.	88.	10 &18	30.	6.	65.	24.	16.5	12.	**61.5**	24.	2.
1898	4.	94.	21.	40.5	1.	85.5	28.	31.	5.	63.	28.	16.	31.	54.	14.	3.
1899	4.	92.	15 &30	**30.**	15.	86.	3.	26.	19.	60.	14.	25.	12.	60.	31.	—1.
1900	12.	95.	19.	37.	6 & 7	**89.**	20.	28.	22.	70.	17.	19.	4.	55.	10 &14	4.
1901	6.	89.	26.	36.	10 &11	74.	28.	28.	1.	65.	27.	13.	14.	62.	18.	—1.
1902	1.	90.	15.	38.	19.	74.	10 & 22 &30	29.	14.	73.	29.	22.	2.	52.	9.	—5.
1903	14.	90.	29.	35.	1.	73.	25 &27	28.	4.	70.	26 &27	12.	3.	46.	19.	—4.
1904	3.	88.	23.	33.	10.	81.	31.	22.	3.	65.	29.	9.	23.	53.	16.	—2.
1905	30.	88.5	26.	36.	1.	85.	26.	**20.5**	12.	61.	14.	11.	29.	52.5	15.	1.
1906	18.	91.5	25.	38.	5.	79.5	13 &31	30.	19.	62.	30.	16.	6.	52.	8.	—1.
1907	20.	90.	27.	39.	†3.	80.	31.	24.	1.	59.	12 &16	22.	30.	57.	22.	13.5
1908	10.	92.	30.	37.	18.	83.	21.	27.	26.	68.	5.	18.	1.	64.	23.	3.
1909	14.	93.	2 & 6	35.	9.	82.5	29 &30	27.	11.	75.	24.	21.	6.	45.	30.	1.
1910	6.	87.	15 &23	40.	6.	81.	30.	26.	1.	59.	23.	21.	29.	41.	31.	—2.5
1911	2.	87.	14.	35.	4.	78.	3.	33.	11.	68.	13.	18.	9.	67.9	4 & 30	13.
1912	6 & 10	95.	30.	34.	6.	83.	16.	31.	6 & 7	69.	28.	20.	6.	65.	9 & 12	12.

* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.
† Thermometer broken on the 27th, 28th, and 29th of October.

YEARLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1912 INCLUSIVE.

(Highest and Lowest Record for THE TIME in Heavy Type.)

	Maximum for Each Year.		Minimum for Each Year.	
	Date.	Temp.	Date.	Temp.
1883	Aug. 23	92.	Jan. 11	— 9.
1884	Aug. 20	95.	Dec. 20	—15.5
1885	July 18	90.5	Feb. 11	—11.5
1886	July 7	95.	Jan. 13	—18.7
1887	July 3	95.5	Jan. 19	— 8.
1888	June 23	94.1	Feb. 10	— 7.
1889	May 18	91.8	Feb. 4 and 24	— 7.
1890	Aug. 4	96.2	Mar. 8	2.
1891	June 16	95.	Feb. 15	2.5
1892	July 29	96.3	Jan. 10	— 5.
1893	July 26	95.5	Jan. 11	— 6.
1894	July 21	97.	Feb. 27	— 8.5
1895*	June 3	96.	Feb. 8	—14.
1896	Aug. 6 and 7	96.	Feb. 17	**—21.**
1897	Sept. 11	98.	Jan. 20	— 3.5
1898	July 4	96.5	Jan. 30 and 31	— 4.
1899	July 4 and Aug. 20	97.5	Feb. 11	— 8.
1900	Aug. 1	97.	Feb. 27	0.
1901	July 1	97.5	Feb. 24	2.5
1902	May 24, July 14 and 27, August 31 and Sept. 1	90.	Dec. 9	— 5.
1903	July 9	94.	Feb. 18 and Dec. 19	— 4.
1904	July 19	93.	Feb. 16	—18.
1905	Aug. 10	93.	Feb. 5 and 14	— 6.
1906	Aug. 5	93.	Feb. 6 and 7	— 7.
1907	Aug. 12	96.5	Jan. 24	—18.
1908	Aug. 4	95.	Jan. 2 and 5	—14.
1909	Aug. 8	98.	Jan. 19	— 7.
1910	July 9	96.5	Jan. 5	— 8.
1911	July 5	**105.**	Jan. 5	— 1.
1912	Sept. 6	95.	Jan. —	—12.

* Data from record kept by Mr. Edgar Parker; Station record not available.

AVERAGE MONTHLY AND YEARLY TEMPERATURES SINCE 1882.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly averages.
1883	17.4	22.3	23.6	43.3	52.0	66.6	67.4	65.6	56.3	46.6	39.1	27.5	44.0
1884	17.6	28.3	29.5	40.7	54.3	67.1	66.5	69.9	65.2	50.5	36.5	27.2	46.1
1885	20.6	11.4	18.8	41.2	54.3	63.6	69.7	65.0	58.3	49.2	39.3	27.8	43.3
1886	19.6	22.9	30.2	48.1	55.7	64.0	68.0	67.5	61.8	49.6	36.8	22.2	45.5
1887	20.2	23.2	26.3	41.1	62.5	65.7	75.6	66.5	57.7	47.0	37.6	27.6	45.9
1888	16.4	22.8	24.6	40.8	54.3	66.5	66.8	68.0	62.2	43.9	39.4	29.3	44.6
1889	29.1	18.1	33.9	45.1	58.4	65.3	70.2	66.0	60.5	44.0	40.3	35.2	47.2
1890	31.2	30.9	28.8	44.2	52.3	67.1	69.5	67.7	60.1	49.3	37.6	21.4	46.7
1891	25.9	28.3	30.8	45.3	52.0	66.4	66.4	68.5	66.2	48.3	38.4	35.5	47.7
1892	21.4	25.9	26.5	43.5	52.8	68.6	70.2	69.4	61.2	50.0	35.9	25.2	45.9
1893	15.5	20.6	29.5	41.1	54.1	68.2	69.8	68.8	58.0	52.0	38.2	27.5	45.3
1894	29.7	20.6	38.9	44.1	55.5	67.8	74.2	66.8	64.9	52.7	36.0	31.5	48.6
1895	21.8	16.9	26.9	44.4	59.0	......	......	71.2	61.7	45.4	39.6	31.4	......
1896	22.4	24.1	24.4	49.3	62.0	65.9	71.4	70.0	60.2	56.5	42.9	27.1	48.0
1897	23.2	26.1	33.8	45.0	55.4	62.3	73.6	67.6	62.3	52.6	39.7	29.2	47.6
1898	26.2	26.8	......	43.2	57.0	67.7	74.2	71.0	65.9	52.1	37.9	27.9	......
1899	22.1	20.4	30.4	46.6	57.6	69.5	71.2	71.6	60.6	53.5	38.9	30.0	47.7
1900	26.0	22.6	23.6	43.5	56.7	68.4	72.6	74.1	66.1	57.9	41.1	28.7	48.4
1901	26.1	18.5	32.2	46.5	56.9	68.9	76.6	71.0	64.0	51.4	34.3	27.7	47.9
1902	23.2	22.2	39.5	46.6	56.1	63.2	71.2	67.6	53.6	43.1	46.3	25.7	47.4
1903	25.7	28.1	42.4	45.9	60.4	63.2	70.8	65.5	64.4	52.5	36.2	23.3	48.2
1904	18.9	23.1	30.9	41.4	60.3	67.8	70.0	68.2	61.9	48.4	36.9	22.5	45.9
1905	19.8	18.9	33.1	44.8	57.5	66.4	71.8	68.7	63.7	52.4	37.6	32.0	47.2
1906	32.5	26.1	27.6	46.4	57.5	68.2	71.4	72.8	67.3	51.2	37.9	26.1	48.8
1907	24.9	19.5	38.1	40.2	51.3	64.0	71.2	68.4	64.4	47.9	38.7	31.8	46.7
1908	25.9	21.3	34.6	44.8	59.2	68.8	73.4	68.8	67.0	52.9	40.0	29.2	48.8
1909	27.7	28.6	31.0	44.3	57.9	67.2	69.6	70.0	63.5	47.7	44.5	25.7	48.1
1910	25.1	22.1	42.1	50.1	54.9	65.2	73.1	69.0	63.2	53.1	35.7	21.5	47.9
1911	24.9	26.6	30.9	44.8	64.9	67.5	74.4	70.9	62.8	50.7	36.6	35.1	49.4
1912	15.9	21.6	28.2	45.1	58.9	64.3	73.2	68.6	68.4	53.5	42.5	33.9	47.8

PRECIPITATION BY RAINFALL ONLY BY MONTHS SINCE 1882.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1882	......	......	......	......	......	3.69	2.42	2.37	1.25	0.62	1.22	0.55	......
1883	0.48	1.44	0.88	1.58	4.45	4.12	2.98	3.47	2.12	2.10	1.54	0.73	25.89
1884	1.83	2.01	2.54	0.83	2.49	2.01	2.33	1.44	3.17	1.67	1.01	0.97	22.30
1885	1.07	0.61	0.12	1.26	1.58	2.49	4.64	5.02	2.11	2.88	1.36	0.76	23.90
1886	1.13	0.95	1.13	4.13	1.92	2.92	4.41	2.86	2.31	1.79	3.48	1.24*	27.87
1887	0.18	2.97	0.48	1.37	0.46	2.01	6.37	3.03	0.75	1.74	1.58	1.35	22.29
1888	0.78	1.04	1.43	3.09	2.79	2.88	0.99+	4.02	2.73	3.47	2.02	1.24	20.48
1889	2.99+	0.25	0.66+	3.28	1.21	7.47	4.57	1.98	2.50	3.32	3.44	1.62	32.28
1890	2.16	1.45	2.16	2.20	5.49	4.26	1.07	4.34	5.81	4.54	2.40	......	36.88
1891	1.44	1.57	3.25	1.63	0.49	4.31	3.52	3.16	0.47	2.65	0.74	3.29	27.52
1892	0.57	0.88	0.55	0.67	4.04	3.95	1.89	4.77	1.12	1.34	1.67	0.72	23.17
1893	1.62	3.71	1.94	2.59	4.92	3.08	2.68	5.38	2.68	1.59	1.09	1.56	33.84
1894	2.21	2.71	1.36	2.43	7.03	1.77	1.50	1.22	4.64	3.59	0.43	0.47	29.36
1895	0.96	......	0.29	1.36	2.88	......	......	2.66	0.94	0.72	2.31	2.49	......
1896	1.19	2.28	0.84	0.41	2.31	3.71	4.12	3.33	4.27	2.26	2.18	0.71	27.61
1897	0.64	0.21	2.12	1.90	2.19	3.16	5.28	1.27	2.36	0.73	2.53	1.39	23.78
1898	1.74	0.33	1.54	2.03	1.90	2.37	1.32	3.60	1.86	3.83	2.03	0.33	22.90
1899	0.37	0.30	1.22	1.12	1.69	1.71	4.15	1.05	2.23	2.69	1.36	1.46	19.35
1900	1.43	2.42	0.02	0.95	1.71	1.45	6.53	1.75	0.91	3.65	6.13	0.78	27.73
1901	0.72	......	2.19	4.43	3.80	2.07	3.97	5.52	2.46	1.35	2.09	3.37	31.97
1902	0.86	0.66	1.94	1.92	2.84	4.33	5.29	2.41	2.88	2.32	0.74	0.74	26.89
1903	1.81	1.11	5.62	2.60	0.23	7.77	4.86	7.21	1.30	4.19	1.63	0.38	38.69
1904	0.80	1.03	2.41	1.67	4.04	3.37	5.73	2.56	3.26	2.06	0.26	1.42	28.61
1905	0.40	0.27	1.09	2.05	2.01	8.78	3.59	5.44	1.90	3.69	1.32	1.84	32.38
1906	1.46	0.53	1.60	2.08	4.24	5.31	2.37	3.68	2.16	3.56	1.40	1.54	29.93
1907	1.89	0.03	1.14	2.42	1.82	2.34	2.86	1.35	2.73	2.48	2.78	1.89	24.73
1908	0.68	1.12	1.24	3.28	3.57	1.96	4.72	1.79	1.66	2.73	0.88	0.43	24.06
1909	0.94	1.68	1.35	3.20	2.83	2.17	2.04	2.21	2.22	1.18	0.56	0.49	20.87
1910	0.87	0.53	0.28	4.56	3.45	1.55	2.39	5.47	3.29	1.73	0.62	0.38	25.12
1911	0.91	0.24	1.07	3.24	1.36	2.51	4.49	3.36	3.21	2.37	1.41	2.08	26.25
1912	0.20	0.95	1.92	3.41	7.27	2.09	4.85	2.21	5.89	1.42	1.48	1.13	32.32

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